

Dr. Dobb's Journal

For Users of Small Computer Systems

G	OPERATION	DESCRIPTION	G	O
3	A <u>v</u> , <u>i</u>	Add <u>i</u> to <u>v</u>	3	N
1	Aa <u>v</u>	Add <u>v</u> to <u>a</u> (<u>v</u> ≠ 1t)	6	N
	ABab	Add BCD <u>lb</u> to <u>la</u>		N
	ABtu	Add BCD <u>lMDu</u> to <u>lM</u>		
4	AMa <u>v</u>	Add <u>a</u> to <u>v</u> (memor)		
4	ASd <u>v2</u>	Arith. shift <u>v2</u>		
	ASd <u>ma</u> , <u>sc</u>	Arith. shift <u>ma</u>		
1	At <u>vx</u>	Add <u>vx</u> to <u>t</u>		
	AXmab	Add extended <u>mb</u>		
	AXmtu	" " <u>mMDu</u> to <u>mMD</u>		
2	Ar <u>v</u>	Arith. shift <u>v</u> (memor)		
B				
	af <u>i2</u>	Test bit <u>i2</u> of <u>a</u>		
	fb	" " <u>b</u> "		
	<u>i2</u>	Test bit <u>i2</u> of		
	<u>i2</u>	Test bit <u>y</u> (in		
	<u>i2</u>	Branch to		
	<u>i2</u>	Test bit <u>i2</u> of		
	<u>i2</u>	" " <u>y</u> (in		
	<u>i2</u>	Branch to		
5		Test bit		
5		Test b		
3		Com		
1	C			
6	C			

$\tan(x) = \sin(x) \cdot 1000$
 $\cos(x)$

934614

1 2 3 4 5 6 7 8 9 0
 Q W E R T Y U I O P
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 Z X C V B N M . ' _

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Z80 Macro-Assembly Implementation

by Herbert Gintis

Software portability often comes at the expense of size and speed. Author Gintis found Pidgin to be low-level, structured and portable. Here he presents his Z80 macro-assembly implementation intended to run under CP/M.

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by W. D. Maurer

Motorola's powerful and versatile 68000 microprocessor offers many features to the experienced programmer. But how does one ever become fluent in its complex assembler mnemonics? As this article points out, redesigning to a simpler mnemonic set may be a reasonable step to take.

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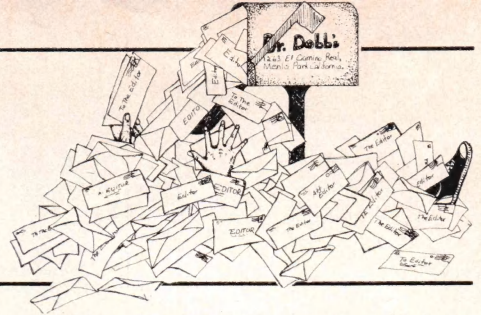
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Dear Gary Kildall . . .

Dear *Dr. Dobb's*,

I found the article comparing CP/M-86 with MS-DOS (and CP/M-80) quite interesting, though I certainly agree with the conclusion that it is disappointing that Digital Research and Microsoft can't come up with anything better than a copy of CP/M-80. In my opinion, the biggest item missing from all three of these systems is I/O redirection.

Recently, Digital Research ran ads in a newspaper in this area for people to work on CP/M for the Motorola 68000. Are we in for yet another copy of CP/M-80? That would be rather like running a Ferrari engine on one cylinder. (It is gratifying, however, that Digital Research has finally recognized that someone besides

Intel makes microprocessors!) I would like to suggest to Digital Research that they use Microware's OS-9tm operating system (for the 6809) as a model for CP/M-68K (or whatever they call it), rather than giving us yet another copy of CP/M-80.

Sincerely,
Jim Howell
5472 Playa Del Rey
San Jose, CA 95123

Micro Compiler in Brobdingnag

Dear Marlin Ouverson,

Enclosed is an article and program submitted for your review and inclusion in *Dr. Dobb's*, if you so desire. Let me add that I enjoy your magazine very much, have all the issues from #1, and it

would be the last magazine I would drop. (I get over thirty engineering or computing magazines.)

I have modified the Small-C compiler to work on a 370 under VM. How's that for reverse engineering? It also has FOR, GOTO, two-dimension arrays, etc.

Regards,
Chris L. Torkildson
13791 Heywood Ct.
Apple Valley, MN 55124

Dear Mr. Ouverson,

I have been using Small-C since the Software Works first offered it for CP/M. I recently got enough memory to allow it to compile itself correctly, and have started implementing all the changes suggested

(Continued on page 59)

Editorial

Going Public . . .

Dr. Dobb's Journal has always championed the cause of public-domain software. It was accidentally founded by a group of idealistic hackers who only wanted to write and publish a tiny Basic interpreter. Their challenge was to fit it in about 4K; their commitment was to put it in the public domain.

This idea — doing good work and letting the public have it with no strings — was so good that readers who managed to get their hands on a copy just wouldn't let *DDJ* finish its intended three-issue life cycle. Instead, seven years later it is the landmark publication for systems software.

One reason for practically giving away perfectly good programs is to enable individuals to build a library of tools for their own use. In the larger sense, of course, commercial products would be greatly enhanced by drawing on some of the truly superb items that have been launched into the public domain. In fact, a number of good packages for sale these days may find their roots in a *Dr. Dobb's Journal* listing, or some other non-proprietary source.

This altruistic influence on end-user technology has, we think, improved the state of the art. The *DDJ* community waves the public-domain flag because we think it is important. With this kind of material, the available computing power is greater than would otherwise be true.

Many generous and sympathetic authors should be thanked for making *DDJ's* mission successful. In addition to our present contributors, we remember the work of Dennis Allison, Steve Wozniak, Gary Kildall, Tom Pittman,

Ron Cain, Li-Chen Wang and Ward Christensen. They are among the many fine people who have used *DDJ* to make important contributions to the microcomputing community.

Unfortunately, the creation of public-domain software is not as popular a pastime as it once was. Maybe, in the beginning, we had more of a sense of community — wonderful machines with unlimited potential, but with nothing more helpful than a row of switches on the front panel. And if you think today's documentation is bad . . . it took a major team effort just to get the things operating.

Now, software protection schemes seem to get more creative thought than the programs they were designed to protect. Instead of sharing resources, one sees even (or perhaps especially) inexperienced programmers becoming canny to any possible profit to be gained or lost. Fortunately, there is still a body of people willing to share their work for just the good feeling, or the prestige, or the common cause of more public-domain software.

In the interest of building the public domain, we encourage authors not to reserve rights to programs published in *DDJ*, even though we will publish ones which reserve commercial rights. If the technical growth potential of computers is going to be realized, it won't be by those large companies with heavy investments in current technology — it will be by individuals working together to push beyond the limits of today's product line. When you hear one of us refer to the *DDJ* community, that's what we mean.

— Marlin Ouverson



by Dave Cortesi

The Very Last SUBMIT Item

For months we have been droning on about the SUBMIT command of CP/M, telling you how useful it can be and showing how to increase its usefulness with fixes and small utilities. In June we showed the utilities PAUSE and BEEP, which increase the operator's control over a submitted job. In August we brought you Robert Pasky's nicely-integrated set of patches that make SUBMIT handle lowercase input, control characters and null lines correctly. With them applied, you can submit command streams to ED and PIP for unattended execution. In September we presented Don Wright's QUITIF program, which gives the designer of a SUBMIT file the ability to check for some errors.

Now, courtesy of Digital Research, we SUBMIT users have the ultimate in SUBMIT patches. The July/August issue of *Microsystems* reproduces, unedited and without commentary, a set of applications notes, the work of the Technical Support Group at Digital Research, Inc. One of these is a lengthy patch which causes SUBMIT to append its output to an existing \$\$\$SUB file, instead of replacing that file. The result is that we can include a SUBMIT command in a submitted job. The inner submit file will be appended to the active submit file; when it completes, the outer submit file will be resumed with the line following the SUBMIT command.

Nested submits! And they come so easily, too. When SUBMIT runs, it places the submitted commands, one per 128-byte record, in reverse order in the file \$\$\$SUB. This was originally done, we think, for the convenience of the Console Command Processor (CCP). The CCP consumes records from \$\$\$SUB from the end of the file toward the beginning. That lets it use the "record count" byte of the directory entry for \$\$\$SUB as its pointer to the next record of the file. It couldn't keep such a pointer in storage, because there is no location in storage that is proof against overlay by an application program.

But this use of \$\$\$SUB makes the file work like a push-down stack. The CCP pops records off the end of the file. The new patch makes SUBMIT push records onto the end of the file, rather than erasing the file and building a whole new one. Nesting of submitted jobs follows automatically.

The Digital Research patch, with our own comments, is shown in Listing 1 (page 58). Assemble it, then use the I and R commands of DDT to overlay its hex file onto a copy of SUBMIT.COM (one with the Pasky Patches applied to it). The updated SUBMIT command does just about everything we could ask of it, so with this item we are turning the whole matter of CP/M SUBMIT over to Gene Head and the *CP/M Exchange*.

Debugging the Debuggers

We've had some letters from people who have problems with the Digital Research debug utilities, DDT and ZSID. L. Barker sent us a note on two holes in ZSID. It doesn't interpret the LDIR instruction correctly when the operands (the two strings defined by the HL, DE and BC registers) overlap on each other. The LDIR (long move) instruction of the Z80 copies a source string into a target string. When the target string overlaps on the source string (as when the source begins at 0200h, the target at 0201h, and the length is 255 bytes), LDIR becomes a Replicate instruction, duplicating the leading byte of the source into the target over and over. ZSID doesn't handle it right, though; it stops after copying one byte.

Barker also noted that the disassembler in ZSID can't seem to handle the "LD A,R" and "LD R,A" instructions. Its List command won't display them and its Assemble command won't accept them.

Gavin Brickell of Auckland, New Zealand, thought that he'd found a bug in DDT, but he hadn't. It appeared that DDT was modifying a word in storage without any reason. However, it had a reason: the word in question was the top word of the stack as defined by the program under test. DDT uses one word on the program's stack in at least three points during the execution of the Go command. The remarkable thing is that DDT manages to get by with only one word of the program's stack; it seems not to need any more.

Dana Trout of Goleta, CA, wrote in with a method for changing the number of the RST vector that DDT uses for breakpoints. One of the Digital Research applications notes mentioned above covers the same area. We think that DDT's use of RST 7 should be left alone if at all possible. DDT (and SID, and ZSID, and any other debugging tool) is going to use

some restart vector, and RST 7 is the one that is documented as being for this use. The great majority of CP/M systems will leave RST 7 free for debuggers. A modified debugger, exported to another system, is quite likely to crash that system by conflicting with a legitimate interrupt vector. Furthermore, there's a good reason for using RST 7 for debug breakpoints: most hardware will return FFh when asked to read from RAM that doesn't exist. FFh is the opcode for an RST 7 instruction; if that is the breakpoint vector, a wild branch to non-existent memory will cause an automatic breakpoint!

Finally, Nick Hammond of Pebble Beach, CA, contributed a cute trick that can be played with DDT. DDT could be useful for poking around in the innards of CP/M, if only it would leave things alone. "The problem with DDT," Hammond writes, "is that it changes things when it gets control. Location 5 no longer points to the BDOS except via a circuitous series of jumps, and the CCP is missing, having

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NOTE: Chart based on manufacturer's information available as of April 4, 1982.

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been overwritten." Hammond supplies a technique for getting a copy of DDT into the transient area below the CCP, and getting control into it with the BDOS vector and the CCP intact. It works like this.

First, invoke DDT as a command, with its own .COM file as argument:

```
A>ddt ddt.com
```

DDT will start up and load DDT.COM. Give the Go command with no address; control will enter the loaded copy. It will relocate itself just below the first-started copy of DDT, clear of the CCP, put its own vector into the RST 7 location, and prompt for a command. Use the Assemble or Substitute command to put an RST 7 instruction at location 0100h. Then use the G0 or a control-c to do a warm start. The CCP will be reloaded over the first copy of DDT, but the second copy will remain. Then create and call a null command file as a means of causing a branch to location 100h, where you stored a

RST 7:

```
A>save 0 null.com
```

```
A>null
```

Control will pass to the RST 7 at location 100, which will return control to the second copy of DDT. You can now use it to peer about the system, observing low storage and the CCP in their native states.

Ask Uncle

"I have a Diablo 1620," says Ernest Knipp of Houston, TX, "and the Courier-10 printwheel has a pound-sterling symbol. I can't get this symbol to print. Is there any way to reach this unreachable character?"

You betcha, Ernest. There are 96 spokes on the Diablo printwheel. Ninety-four of them print in response to the 94 printing characters of the ASCII code. Two of the spokes correspond to the ASCII space (32h) and the DEL (7Fh) codes. Those two can't be reached by sending the printer a single ASCII code.

When it gets a space, the printer just advances the carriage; it doesn't use the printwheel at all. And it conforms to the ASCII standard by ignoring DEL characters entirely.

However, the manual for our 1650 printer says that the sequence ESCape, "Y" will print the spoke matching 32h, and ESCape, "Z" will print the one matching 7Fh. In other words, if your printer receives the two bytes 1Bh, 59h, it should print the sterling symbol. If it receives the bytes 1Bh, 5Ah, it should print a logical-not symbol.

Assorted Grumps

A person who would rather remain anonymous has told us that he had it from an equally anonymous, but supposedly well-informed, source that the code of the IBM PC's BASIC interpreter was indeed produced by an 8080-to-8086 translator program. That's all very

(Continued on page 58)

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68000 Cross Assembler

The June 1982 issue of *DDJ* contained a brief description of the computer system which is being developed by myself, Darryl Uchitil, and Jim Hannas as a test bed for system software and hardware using the Motorola 68000 microprocessor. The reader response to both *DDJ* and myself as a result of that article has been interesting and informative to Jim, Darryl and myself, and I would like to thank all of you who have called or written me since June. I will present at the end of this article a summary of answers to some of the most frequently asked questions about our system for the benefit of those who have not tried to contact me or who have written but have not yet received my reply.

Cross-Assembler Description

This article will describe the cross assembler that was mentioned in the June 1982 issue of *DDJ*. It was developed because we needed a way to write small programs for execution on a single 68000 processor to test the hardware and to

by Al Kossow

Allen Kossow, Medical College of Wisconsin, Department of Physiology, 8701 Watertown Plank Road, Milwaukee, WI 53226.

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test the interface between the 68000 processors and the I/O bus control processor. The cross assembler for the 68000 has been run on two different PDP-11 systems, one running RT-11, and one running RSX-11M. It has also been run on a VAX/VMS system under the applications migration executive. It should be possible to adapt the assembler to other machines by recoding assembly-language subroutines for 32-bit arithmetic and modifying the routines that reference octal constants, but as of this writing, no attempt has been made to do so.

The cross assembler consists of a main program and a collection of subroutines, each performing part of the assembly process. The cross assembler is a two-pass assembler; the source code is read twice by the program. The first pass through the source code picks up all of the labels, and the second pass generates the listing and object files. All operations to files are handled by individual subroutines. These subroutines are SOURCE, LIST, and OBJECT. All machine-dependent routines for opening and closing of files are located in these routines.

Each of the three routines for the source, listing and object files is called when the program is first started, to determine where each is to be sent. Some checking is done to determine if just a carriage-return was typed, so that there is a default of only a listing to the terminal and no object file is established. Once the source for the assembler and the destinations of the listing and object are established, the assembler starts the assembly by setting the pass number to one and calls the subroutine PARSE.

PARSE scans the input line and determines if the statement is just a comment. If it is not a comment, it splits apart the label, opcode and operand fields of the statement, and returns pointers to these fields to be used by the statement evaluation routines.

After the line is parsed, the statement opcode is evaluated by the subroutine PROCESS. PROCESS calls DECOPC, which takes the characters pointed to by the opcode pointer from PARSE and attempts to find an opcode that matches. If an opcode is found, the values of one or more skeletal opcodes (opcodes without effective addresses or sizes) are returned.

After evaluating the opcode, the operands are evaluated to determine their general type. All "simple" operands, such as registers, are evaluated immediately, while "complex" operands (i.e., operands containing labels) are not evaluated.

If a valid opcode skeleton was returned, there will be a number returned by DECOPC which represents a general way in which to evaluate this type of operation. This number is used by PROCESS in a multi-way branch to different sections of code for evaluation of the opcode. Once in the specific section of code for the opcode, the operands are checked for validity in the opcode, and if the operand was "complex" it is evaluated and a value is returned.

Each specific section of code for an opcode builds up the opcode skeleton, filling in the size and effective address fields as necessary for that type of instruction. The result of this evaluation is an array of 16-bit values which represent the result of that line of the assembly, and a count of the number of words generated by that line.

At the end of the opcode processing routine is the section of code that handles labels. If a label was detected and is valid for the opcode type, the current value of the location counter is placed in the symbol table entry for that label.

If this is the second pass, the object and listing is generated based on the values in the instruction word array; otherwise, the next line is fetched and the evaluation process is repeated. After the last line of the program is read, the input file is closed, and a routine is called to print the contents of the symbol table.

Frequently Asked Questions About The Multi-68000 System

Q: Can I get a copy of your assembler?

A: If you don't feel like typing in the source code in this article, I can send you the source as it appears here on an 8" single-sided, single-density floppy disk in either CP/M or RT-11 format for \$25 on an as-is, no-support basis. I can provide the source on a CP/M disk, but I have no way to compile it or test it there.

Q: What is CLICS? Where can I get it?

A: CLICS is a collection of subroutines for 2-D graphics developed by Mike Garrett while he was with the Department of Defense. Since the time I wrote the article, I have heard that Mike left DOD and started a company selling graphics software written in C. I have not been able to reach him to determine if this is true or not. The CLICS software I have been working with came off of the 1980 Spring DECUS RSX-11 special interest group symposium tape. This tape is available from the DECUS library.

Q: When/where can I buy one of your systems?

A: The notion of selling this system has been discussed a number of times between the three of us, but we just don't want to get into the computer business. The schematics and blank PC boards will probably be available from us on an as-is, no-support basis, along with the software we develop, but we have no plans to sell or support systems.

Q: Why didn't you build your system on a "XYZ" bus?

A: I had expected much more flack about using the PUNIBUS than I actually received. The primary reason for not using a commercial bus was the desire to build a system which had a few large (8" by 15") cards to minimize the number of cards to build. We also probably would not have used a special bus if we had planned on selling the system once we finished it.

In closing, I would like to thank all of you that have taken the time to call or write me about our project, and will promise to keep you informed of our progress in future issues of *DDJ*.

DDJ

(Listing begins on page 14)

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C = 2.0*pi*r;**

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68000 Cross Assembler (XASM)

(Text begins on page 12)

Due to its length, this listing will be continued next month.

Listing One

```
C      PROGRAM MAIN
C
C      M68000 CROSS-ASSEMBLER MAIN PROGRAM
C
C
C      C DATE:    FEBRUARY 10, 1981
C
C
C      C REVISION: X1.0      (EXPERIMENTAL PRE-RELEASE)
C
C
C      C AUTHOR:   Allen Kossov
C                  Medical College of Wisconsin
C                  Department of Physiology
C                  8701 Watertown Plank Rd.
C                  Milwaukee, WI 53226
C
C
C      C PGM NOTES:
C
C          Symbols are unique to 8 chrs.
C          Symbol table size is currently set to 512.
C          Symbol table size is determined by the memory constraints
C            of the machine it's running on. The current symbol table
C            size works under RT-11 with 64kb of memory and under RSX-11.
C
C          This program follows most of the conventions of the
C            Motorola 68000 assembler with the following exceptions:
C
C            1) no macros or pc relative addressing (except branches)
C            2) generalized (i.e., simple) object file format
C            3) listing format similar to that of MACRO-11
C            4) doesn't handle adr regs as special cases (i.e., MOVEA is just a MOVE)
```

(Continued on column 2)

```

C      C..... READ ONE LINE OF SOURCE FILE
C
15     C      CALL I4CLR(NEWPC)
C      CALL SOURCE(2)
C
C      C..... IF EOF DETECTED DO PASS 2
C
C      C..... IF (ISERR.EQ.1) GOTO 20
C
C      C..... RESET MULTIPLE ERROR FLG
C      MEFLG = 0
C
C      C..... PARSE SOURCE LINE
C      CALL PARSE
C
C      C..... IF NULL LINE GET NEXT LINE
C      IF (PRFLG.EQ.0) GOTO 15
C
C      C..... PROCESS SOURCE LINE
C      CALL PROCESS
C
C      C..... IF END DETECTED DO PASS 2 ELSE GET NEXT LINE
C
C      C..... IF (ISERR.EQ.1) GOTO 20
C      I=JADD(PC,NEWPC,PC)
C      GOTO 15
C
C      C..... DO PASS 2
C
C      C..... REM SOURCE SET TO PASS 2 AND RESET PC
C
20     C      CALL SOURCE(3)
C      PASS=2
C      IERCNT = 0
C      CALL I4CLR(PC)
C      CALL I4CLR(HEXPC)
C      CALL I4CLR(OLUPC)
C
C      C..... FLUSH PRINT BUFFER IN CASE ANYTHING LEFT
C      FROM LAST ASSEMBLY
C
25     C      DO 25 I=1,132
C      PL(I) = *40
C
C      C..... INITIALIZE OBJECT BUFFER
C

```

(Continued on page 16, column 1)

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Dealer inquiries invited. We support our dealers.

68000 Cross Assembler (XASM)

(Listing continued, text begins on page 12)

Listing One

```

C      ENDFLG = 0
C      HEXMC = 0
C      PRINT FIRST PAGE HEADING
C
C....
C
30    CALL NEWPAGE
      CALL IACLR(MEUPC)
      ORJMC = 0
      CALL SOURCE(2)
C
C....
C      EOF DETECTED
C
C      IF (ISERR.EQ.1) GOTO 50
C....
C      RESET MULTIPLE ERROR FLG
C
C      MEFLG = 0
C....
C      PARSE LINE
C
C      CALL PARSE
C
C....
C      PRINT A LINE OF ONLY COMMENTS NORMALLY
C
C      IF (CMPTTR.EQ.1) GOTO 40
C....
C      CHECK FOR PARSING ERRORS
C
C      IF (PRFLG.EQ.0) GOTO 30
C....
C      PROCESS IT
C
38    CALL PROCESS
C....
C      GENERATE LISTING
C
40    CALL LISTLINE
C
C....
C      CHECK IF THERE IS OBJ CODE TO GENERATE
C
C      IF (OBJJMC.EQ.0) GOTO 45
      CALL BLDOBJ
C....
C      DO NEXT LINE IF NOT END
C
45    IF (ISERR.EQ.1) GOTO 50
      I=JADD(PC,MEUPC,PC)
      GOTO 30
C
C....
C      END OF ASSEMBLY, OUTPUT BALANCE OF OBJ BUFFER

```

```

C
200    ISERR=0
      READ(1,210,END=250) (SRCLINE(1),I=1,80)
210    FORMAT(80A1)
      NOCARD=NOCARD+1
C
C CONVERT ALL CHARACTERS
C
      DO 225 I=1,80
        IF (SRCLINE(1).GE.32) GO TO 220
          SRCLINE(1)=32
          GO TO 225
220    IF (SRCLINE(1).LT.96) GO TO 225
          SRCLINE(1)=SRCLINE(1)-32
          IF (SRCLINE(1).GE.96) GO TO 215
          CONTINUE
225    C
C REMOVE TRAILING BLANKS
C
      LMLEN=80
      IF (SRCLINE(LMLEN).NE.32) GO TO 240
      LMLEN=LMLEN-1
      IF (LMLEN.GT.0) GO TO 230
      LMLEN=LMLEN+1
      SRCLINE(LMLEN)=0
      GO TO 500
C
C END OF FILE
C
250    ISERR=1
      GO TO 500
C
C REWIND SOURCE FILE
C
300    REWIND 1
      NOCARD=0
      GO TO 500
C
C CLOSE SOURCE FILE
C
400    CLOSE (UNIT=1)
500    RETURN
      END
      SUBROUTINE LIST(LCODE)
C
C PERFORMS OPEN AND CLOSE ON LIST FILE
C
C INPUT:LCODE = 1 => OPEN FILE (NAME READ FROM KEYBOARD)
C           2 => CLOSE FILE
C
      BYTE FILNAM(12)
      INTEGER PASS
      BYTE NAME(8)
      COMMON /LST/ LUNIT,PASS,NAME,NOPAGE,NOLINE,MEFLG,IERCNT
      COMMON /FNAM/ FILNAM,OBJJFLG

```



```

C
50  ENDFLG = 1
    CALL BLNDBJ
C
C,... PRINT SYMBOL TABLE
C
C    CALL PST
C
C,... CLOSE FILES AND DO IT AGAIN
C
    CALL SOURCE(4)
    CALL LIST(2)
    CALL OBJECT(2)
    GOTO 5
    END
    SUBROUTINE SOURCE(ICODE)
C
C PERFORMS ALL OPERATIONS OF SOURCE INPUT FILE
C
C INPUT:
C ICODE = 1 => OPEN SOURCE FILE (NAME READ FROM KEYBOARD)
C        2 => READ ONE LINE FROM SOURCE FILE INTO
C            'SRCLINE' (8001 FORMAT), TRAILING BLANKS
C            ARE DELETED, ZERO CHAR IS INSERTED AT
C            THE END OF THE LINE.
C        3 => REWIND SOURCE FILE.
C        4 => CLOSE SOURCE FILE.
C
C OUTPUT:
C
C SRCLINE = SOURCE LINE FOR CODE 2
C LNLLEN = LENGTH OF LINE FOR CODE 2
C ISERR = 1 IF END OF FILE ON READ (ZERO OTHERWISE)
C NOCARD = CARD NUMBER READ FROM SOURCE (1-7)
C
    BYTE FILNAM(12)
    BYTE SRCLINE(81)
    COMMON /SRC/LNLLEN,ISERR,NOCARD,SRCLINE
    COMMON /FNM/ FILNAM,OBJFLG
C
C SELECT FUNCTION
C
    GO TO (100,200,300,400),ICODE
C
C OPEN SOURCE FILE
C
    TYPE 110
    110  FORMAT('$$$rc file name: ')
    READ (5,120) ICNT,FILNAM
    120  FORMAT(0,12A1)
    IF(ICNT.EQ.0) STOP
    CALL ASSIGN(1,FILNAM,ICNT)
    NOCARD=0
    GOTO 500
C
C READ SOURCE LINE

```

(Continued on page 16, column 2)

```

C
C SELECT FUNCTION
C
    GO TO (100,200),ICODE
C
C,... ASSIGN DEFAULT LISTING TO CONSOLE
C
    LUNIT=5
    TYPE 110
    110  FORMAT('$$$l file name: ')
    READ (5,115) ICNT,FILNAM
    115  FORMAT(0,12A1)
    IF(ICNT.EQ.0) GOTO 116
C
C,... IF THERE IS A FILENAME ASSIGN LISTING TO LUN 3
C
    LUNIT = 3
    CALL ASSIGN(LUNIT,FILNAM,ICNT)
    NPAGE=0
    GO TO 300
C
C CLOSE FILE
C
    200  IF(LUNIT.EQ.5) RETURN
    CALL CLOSE(LUNIT)
    300  RETURN
    END
    SUBROUTINE OBJECT(ICODE)
C
C PERFORMS OPEN AND CLOSE ON OBJECT FILE
C
    BYTE FILNAM(12)
    INTEGER PASS
    BYTE NAME(8)
    COMMON /LST/ LUNIT,PASS,NAME,NPAGE,NOLINE,NEFLG,IERCNT
    COMMON /FNM/ FILNAM,OBJFLG
    GO TO (100,200),ICODE
    TYPE 110
    110  FORMAT('$$$b file name: ')
    READ (5,115) ICNT,FILNAM
    115  FORMAT(0,12A1)
    IF(ICNT.EQ.0) GOTO 116
    CALL ASSIGN(2,FILNAM,ICNT)
    OBJFLG = 1
    RETURN
    116  OBJFLG = 0
    RETURN
    200  IF(OBJFLG.EQ.0) RETURN
    CALL CLOSE(2)
    RETURN
    END
    SUBROUTINE SYNTAX(ICODE,IADDR,SYNSTR)
C
C SYMBOL TABLE PROCESSOR
C

```

(Continued on page 16, column 3)

```

    IF (SYNSYN(J,STIND),LT,SYMBOL(J)) GOTO 120
    IF (SYNSYN(J,STIND).EQ.SYMBOL(J)) GOTO 118
    NDFLGL = 1
    GOTO 200
    118  CONTINUE
    120  CONTINUE
C
C SYMBOL WAS NOT FOUND
C
    200  IF(NDFLGL.LT.513) GO TO 210
    CALL ERROR(221)
    STIND=513
    GOTO 400
    210  IF (NDFLGL.EQ.0) GOTO 218
    ITEMP = NDFLGL
    211  DO 212 J=1,4
    212  SYNSYN(J,ITEMP+1) = SYNSYN(J,ITEMP)
    CALL JMOV (SYNAADR(ITEMP),SYNAADR(ITEMP+1))
    SYNFLG(ITEMP+1) = SYNFLG(ITEMP)
    SYNLIN(ITEMP+1) = SYNLIN(ITEMP)
    ITEMP = ITEMP + 1
    IF (ITEMP.GE.STIND) GOTO 211
    NDFLGL = NDFLGL + 1
    DO 220 J = 1,4
    220  SYNSYN (J,STIND) = SYNSYN(J)
    IF(ICODE.EQ.1) GO TO 250
    SYNFLG(STIND)=4
    CALL IACLR(SYNAADR(STIND))
    I=IADDR(SYNAADR(STIND),IADDR,SYNAADR(STIND))
    SYNLIN(STIND) = NOCARD
    GOTO 400
    250  CALL IACLR(SYNAADR(STIND))
    SYNFLG(STIND)=1
    SYNLIN(STIND) = 0
    GOTO 400
C
C SYMBOL FOUND
C
    300  IF(PASS.EQ.2.OR.ICODE.EQ.1) GOTO 400
    IF(SYNFLG(STIND).NE.1) GO TO 310
    SYNFLG(STIND)=2
    CALL IACLR(SYNAADR(STIND))
    I=IADDR(SYNAADR(STIND),IADDR,SYNAADR(STIND))
    SYNLIN(STIND) = NOCARD
    GOTO 400
    310  SYNFLG(STIND)=SYNFLG(STIND).OR.8
    400  RETURN
    END
    SUBROUTINE CRNHEX(INDEX)
C
C CONVERTS 4 BITS TO HEX ASCII AND INSERTS INTO 'PL' AT 'INDEX'
C
C INPUT: WORD = VALUE
C INDEX= WHERE TO INSERT IN PL
C

```

(Continued on next page)

68000 Cross Assembler (XASM)

(Listing continued, text begins on page 12)

Listing One

```

C OUTPUT:
C   WORD = WORD/16
C
C   BYTE PL(132),DIG
C   INTEGER WORD
C   COMMON /CNVT/ WORD,PL
C   CALL GETBIT(WORD,DIG)
C   PL(INDEX)=DIG
C   RETURN
C   END
C   SUBROUTINE INSDAT(IPL,IDI6)
C
C   CONVERTS BINARY DATA TO HEX ASCII AND INSERTS INTO 'PL'
C
C   INPUT: IPL = INDEX TO INSERT INTO PL
C   IDI6= NUMBER OF DIGITS TO CONVERT AND INSERT
C   WORD= VALUE TO CONVERT (IN COMMON - NOT REFERENCED HERE)
C
C   I=IDI6
C   J=IPL+1
C   CALL CRWEX(J)
C   I=I-1
C   IF(I.LE.0) RETURN
C   GO TO 5
C   END
C
C   SUBROUTINE INX(132,IDI4,IPPOS)
C
C   PRINT A 4 OR 8 DIGIT HEX VALUE
C   C NUMBER OBTAINED STARTING AT 'WORD'
C   C AND PUT INTO PRINT BUFFER 'PL' STARTING IN COL 1
C
C   IMPLICIT INTEGER (A-Z)
C   COMMON /CNVT/ WORD,PL
C   COMMON /LST/ LUNIT,PASS,NAME,NOPAGE,NOLINE,NEFLG,IERCNT
C   BYTE PL(132),NAME(8)
C   DIMENSION IDI4(3)
C   PL(1)=32
C   IF(132.EQ.2) GO TO 15
C   WORD=IDI4(1)
C   CALL INSDAT(IPPOS+4)
C   RETURN
C   WORD=IDI4(2)
C   CALL INSDAT(IPPOS+4)
C   WORD=IDI4(1)
C   CALL INSDAT(IPPOS+4,4)
C   RETURN
C   END

```

```

SUBROUTINE NEWPAS
IMPLICIT INTEGER (A-Z)
C PUTS OUT HEADERS AT TOP OF EACH PAGE
C
C   INTEGER PASS
C   BYTE NAME(8),FF
C   COMMON /LST/ LUNIT,PASS,NAME,NOPAGE,NOLINE,NEFLG,IERCNT
C   FF='14'
C   NOPAGE=NOPAGE+1
C   NOLINE = 57
C   IF(NOPAGE.EQ.1) FF = 0
C   WRITE(LUNIT,10)FF,NAME,NOPAGE
C   FORMAT(' ',1A1,8A1,T28,'68000 CROSS-ASSEMBLER XL.0
C   +',T83,'PAGE ',I3,/)
C   RETURN
C   END
C   SUBROUTINE PASCHK
C   IMPLICIT INTEGER (A-Z)
C   C CHECKS TO SEE IF A PAGE HAS BEEN FILLED
C
C   BYTE NAME(8)
C   COMMON /LST/ LUNIT,PASS,NAME,NOPAGE,NOLINE,NEFLG,IERCNT
C   IF(NOLINE.EQ.0) CALL NEWPAS
C   RETURN
C   END
C   SUBROUTINE ERROR(IERR)
C   IMPLICIT INTEGER(A-Z)
C   C AND PRINTS ERROR MESSAGE DURING PASS 2
C
C   COMMON /LST/ LUNIT,PASS,NAME,NOPAGE,NOLINE,NEFLG,IERCNT
C   COMMON /SRC/ LNELEN,ISERR,NOCARD,SRCLNE
C   COMMON /PASE/ OPPTTR,MODPTR,OPNPTR,LABEL,CHPTR
C   +,PFLG,SCAPT,OPCLEN,OPNPT2,INODE
C   COMMON /OBJOUT/ OBJBUF,OBJMC,LELG,RELG,OBJFLG
C   DIMENSION OBJBUF(40)
C   COMMON /SYNT/STIND,SYNADR,PC,NOSYN,NEWPC,SYNFLG
C   INTEGER I4 PC,NEWPC,SYNADR(512)
C   LOGICAL I1 SYNFLG(513),ERRPTR(80),NAME(8),SRCLNE(81)
C   LOGICAL I1 LABEL(8)
C
C   ERRORS ARE IGNORED DURING THE FIRST PASS
C
C   IF(PASS.EQ.1) RETURN
C
C   PFLG = 3
C
C   WE NEED AT LEAST THREE LINES TO PRINT AN BAD LINE
C
C   IF(NOLINE.LE.2) NOLINE = 0
C   CALL PASCHK
C
C   IF THIS IS NOT THE FIRST ERROR THEN DON'T PRINT THE LINE
C
C   IF (NEFLG.EQ.1) GO TO 15
C   WRITE(LUNIT,10) NOCARD,(SRCLNE(I),I=1,LNELEN-1)

```

```

C
C   LSWRDS = OBJMC
C   IF(OBJMC.GT.5) LSWRDS=5
C
C   CHECK IF WE HAVE TO GO TO NEXT PAGE
C   CALL PASCHK
C
C   IF(CHPTR.NE.1)GO TO 80
C   OPPTTR=1
C   GO TO 220
C   GO TO 200,200,200,410,500,600,200,200,400),PFLG+1
C   CALL INX(2,PC,7)
C
C   IF(LSWRDS.EQ.0) GO TO 212
C   DO 210,I=1,LSWRDS
C   CALL INX(1,OBJBUF(1),11+(581))
C
C   IF(LABEL(1).EQ.0) GO TO 220
C   DO 215,I=1,8
C   PL(1+40)=LABEL(I)
C   J=0
C   DO 230 I=OPPTTR,LNELEN
C   PL(J+50)=SRCLNE(I)
C   IF(SRCLNE(1).EQ.'40') GO TO 240
C   J=J+1
C   GO TO 1000
C   III=0
C   DO 250 II=1+1,LNELEN
C   IF (II.EQ.CHPTR) III = 25
C   PL(57+III)=SRCLNE(II)
C   III = III + 1
C   IF ((III + 57).GT.132) GO TO 255
C   GO TO 1000
C   PL(132) = 0
C   GO TO 1000
C
C   PFLG = 3 (NEW PAGE)
C   CALL NEWPAS
C   RETURN
C
C   GO TO 205
C   GO TO 220
C
C   CALL INX(2,OBJBUF(2),16)
C   GO TO 212
C
C   DO 1001 I=48,132

```


10	SUBROUTINE PST	1001	IF (PL(1),EQ,0)GOTO 1002
15	C SORT AND PRINT SYMBOL TABLE	1002	WRITE(LIMIT,1110) NOCARD,(PL(11),I1=6,I-1)
20	C	1110	FORMAT(' ',14,132A1)
30	C	1120	DO 1120 I1 = 1,I
	INTEGER PASS,STIND,SYNLIN(512)		PL(I1) = '40
	INTEGER4 PC,NEUPC,SYNAUR(512)		NOLINE = NOLINE - 1
	BYTE NAME(8),SYNSYN(8,512),SYNFB(513),PL(132)		RETURN
	COMMON/LST/LIMIT,PASS,NAME,NOPAGE,NOLINE,NEFLG,IERCMT		END
	COMMON/SYMN/SYNSYN,SYNLIN		SUBROUTINE BLDOBJ
	COMMON/SYNT/STIND,SYNAUR,PC,NOSYN,NEUPC,SYNFB		IMPLICIT INTEGER (A-Z)
	COMMON /CNVT / WORD,PL		
	IF (NOSYN.EQ.0) RETURN		BUILD OBJ FILE
	C START OUT WITH CLEAN BUFFER		COMMON /FNAM / FILNAM,OBJFLG
	C		COMMON /OBJOUT/ OBJBUF,OBJJAC,LF1G,RF1G,DIRFLG
50	DO 50 I = 1,132		COMMON /CNVT / WORD,PL
	PL(I) = '40		COMMON /SYNT / STIND,SYNAUR,PC,NOSYN,NEUPC,SYNFB
	C		COMMON /HEXFLG/ ENDFLG,HEXMC,HEXPC,OLDFLG
	C GOTO TOP OF PAGE		DIMENSION OBJBUF(40),HEXBUF(8)
	C		INTEGER4 PC,NEUPC,SYNAUR(512),OLDFG,NEUVAL,HEXPC
	CALL NEUPAG		LOGICAL \$1 SYNFB(513),PL(132),FILNAM(12)
	GENERATE THE SYMBOL LIST A LINE AT A TIME		CHECK IF OBJ FILE IS TO BE GENERATED
	DO 300 I = 1,NOSYN,5		IF (OBJFLG.EQ.0) RETURN
	DO 210 IDX=0,4		CHECK FOR THE END OF ASSEMBLY FLAG
	IF (I+IDX,GT,NOSYN) GOTO 290		IF IT IS SET, WRITE OUT THE BALANCE OF THE OBJ BUFFER
	DO 170 IPT=1,7,2		IF (ENDFLG.EQ.0) GOTO 10
170	PL(IPT+(IDXX24)+1) = SYNSYN(IPT,(I+IDX))		IF (HEXMC.NE.0) CALL WRTOBJ(HEXPC,HEXMC,HEXBUF)
	PL(IPT+(IDXX24)) = SYNSYN(IPT+1,(I+IDX))		RETURN
	CALL INX(2,SYNAUR(I+IDX),(IDXX24)+12)		CHECK THE CURRENT VALUE OF THE PC WITH THAT OF THE ONE SAVED
	IFTRP = SYNFB(I+IDX)		IF THE TWO ARE NOT EQUAL, THEN WRITE OUT THE BALANCE OF THE
	IF ((IFTRP.AND.16).NE.16) GOTO 180		OBJ BUFFER AND START AT THE NEW PC VAL
	PL((IDXX24)+19) = 'E'		CALL DBLSL(PC,PC1,PC2)
	PL((IDXX24)+20) = 'Q'		CALL DBLSL(OLDFG,OLDFC1,OLDFC2)
180	IF ((IFTRP.AND.8).NE.8) GOTO 190		IF (PC1.NE.OLDFC1) GOTO 50
	PL((IDXX24)+19) = 'N'		IF (PC2.EQ.OLDFC2) GOTO 75
	PL((IDXX24)+20) = 'U'		IF (HEXMC.NE.0) CALL WRTOBJ(HEXPC,HEXMC,HEXBUF)
190	IF ((IFTRP.AND.1),NE.1) GOTO 200		CALL JNOV(PC,HEXPC)
	PL((IDXX24)+19) = 'U'		CALL JNOV(PC,OLDFC)
	PL((IDXX24)+20) = 'N'		EXTRACT OBJECT WORDS FROM OBJECT BUFFER AND
200	IF ((IFTRP.AND.'31').NE.0) GOTO 210		PUT THEM INTO AN INTERNAL BUFFER, IF THE
	PL((IDXX24)+19) = ' '		INTERNAL BUFFER IS FULL, THEN OUTPUT THE BUFFER.
	PL((IDXX24)+20) = ' '		
210	CONTINUE		
290	WRITE (LIMIT,400) (PL(N),N=1,IDXX24)		
	NOLINE = NOLINE -1		
300	CALL PAGCHK		
400	CONTINUE		
	FORMAT (' ',132A1)		
410	WRITE (LIMIT,410) NOSYN,IERCMT		
	FORMAT (/,' ',13,'SYMBOLS ',13,' ERRORS DETECTED')		
	IF (LIMIT.EQ.5) RETURN		
	WRITE (5,410) NOSYN,IERCMT		
	RETURN		
	END		

(Continued on page 18, column 2)

(Continued on page 18, column 3)

(Continued on next page)

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Listing One

```
C.... OBJECT BUFFER IS FULL; OUTPUT IT TO OBJ FILE
```

2

N = JICVT(I12,NEWVAL)

$$Y = Y + 1$$

CALCULATE WHAT THE NEW PC

100

END

(77-H) 17301 INT 17377 INT

HEXBUF = 8 WORD OBJECT BUFFER

COMMON /CMVT/ WORD,PL

2010 RELEASE UNDER E.O. 14176

PL(I) = '40
CALL TEND(I, N, M, A)

DO 20, I=1, HEXMC

```
WRITE (Z,100)(PL(I),I=3,10)
ENDDAT(, , -9991)
```

DO 900, I = 1,80

RETURN
END

APPENDIX A

342

332

21

68000 Cross Assembler (XASM)

(Listing continued, text begins on page 12)

Listing One

```

C      IF(OP1EA,EO.7,OR.,OP1EA,EO.9) GOTO 350
C      C,....
C      OP1EA = 1 THRU 5
C      IF((OP1EA,GE.1),AND,(OP1EA,LE.5)) GOTO 305
C      C,....
C      PROCESS FIRST OPM HERE IF COMPLEX
C      CALL PROCOP(OPMPTR)
C      C,....
C      CHECK FOR EA TYPES 7-9
C      303 IF(OP2EA,GT.6) GOTO 340
C      C,....
C      CHECK FOR FIRST OPERAND IMMEDIATE MODE ADDRESSING
C      IF (OP1EA,NE.6) GOTO 304
C      C,....
C      SKIP MOVQ IF FWD REF SYMBOL
C      IF(OPNFG,EO.1) GOTO 304
C      IF(INODE,NE.3) GOTO 304
C      IF(OPNWD(3),EO.0) GOTO 301
C      IF(OPNWD(3),EO.-1) GOTO 301
C      GOTO 304
C      C,....
C      CHECK IF VAL WITHIN RANGE FOR MOVQ (+/- 128)
C      C,....
C      ALSO CHECK IF DESTINATION IS A DATA REGISTER
C      301 I=ICVVAL(OPNWD(2))
C      IF ((I,EO.0),AND,(OP2EA,EO.1)) GOTO 330
C      C,....
C      ADD IN OPCODE SIZE BITS
C      304 OBUJUF(1)=OBUJUF(1),OR, *30000
C      IF (INODE,EO.1) OBUJUF(1)=(OBUJUF(1)),AND, *17777
C      IF (INODE,EO.3) OBUJUF(1)=(OBUJUF(1)),AND, *27777
C      C,....
C      MOVE IN NUMBERS FOR 1ST AND 2ND EXT WORDS
C      OBUJC = OBUJC+OPNWD(2)
C      OBUJUF(2) = OPNWD(2)
C      OBUJUF(1) = OPNWD(1)
C      IF (OPNWD,EO.2) OBUJUF(2) = OPNWD(3)
C      IF (OPNWD,EO.2) OBUJUF(3) = OPNWD(2)
C      GOTO 310
C      C,....
C      PROCESS EA TYPES 0-5 FOR FIRST OPM
C      310 GOTO 7000
C      C,....
C      HANDLE STUFF FOR EA'S 0 AND 6
C      349 OBUJUF(1)=OBUJUF(1),OR,OPNWD(1)
C      OBUJUF(2)=OPNWD(2)
C      IF(OPNWD,EO.2)OBUJUF(2)=OPNWD(3)
C      IF(OPNWD,EO.2)OBUJUF(3)=OPNWD(2)
C      OBUJC=OBUJC+OPNWD
C      GOTO 7000
C      C,....
C      GENERATE MOVE SR<EA> - USP,AM
C      350 IF (OP1EA,EO.9) GOTO 355
C      IF (OP2EA,EO.2) GOTO 8500
C      IF (OP2EA,EO.0) GOTO 353
C      OBUJUF(1) = *40300,OR,OP2DA,OR,((OP2EA-1)*10)
C      GOTO 7000
C      C,....
C      CALL PROCOP(OPMPT2)
C      OBUJUF(2)=OPNWD(2)
C      IF(OPNWD,EO.2) OBUJUF(2) = OPNWD(3)
C      IF(OPNWD,EO.2) OBUJUF(3) = OPNWD(2)
C      OBUJC = OBUJC + OPNWD
C      OBUJUF(1) = *43000,OR,OPNWD(1)
C      GOTO 7000
C      355 OBUJUF(1) = *47150,OR,OP2DA
C      GOTO 7000
C      C,....
C      ++++++
C      C      PROCESS CMP INSTRUCTION
C      <EA>,DM <EA>,AM DATA<EA> (AY)+, (AX)+
C      C,....
C      ++++++
C      400 IF((OP1EA,EO.6),AND,(OP2EA,NE.2)) GOTO 460
C      IF((OP1EA,EO.5),AND,(OP2EA,EO.5)) GOTO 480
C      IF((OP2EA,EO.1),OR, (OP2EA,EO.2)) GOTO 410
C      GOTO 8500
C      C,....
C      PROCESS <EA>,DM <EA>,AM
C      410 IF(OP2EA,EO.2,AND,INODE,EO.1) GOTO 8500
C      IF(OP2EA,NE.2) GOTO 411
C      IF (INODE,EO.3) OBUJUF(1) = OBUJUF(1),OR, *500
C      IF (INODE,NE.3) OBUJUF(1) = OBUJUF(1),OR, *200
C      IF((OP1EA,EO.0),OR,(OP1EA,EO.6)) GOTO 415
C      C,....
C      PROCESS FOR REG OPNS
C      411 OBUJUF(1)=OBUJUF(1),OR,((OP1EA-1)*10),OR,OP1DA
C      GOTO 6000
C      C,....
C      PROCESS FOR COMPLEX 1ST OPNS
C      537 GOTO 7000
C      C,....
C      GENERATE DM<EA>
C      OPUKEL = OPUKEL,OR,(OP1DA*1000)
C      IF(OP2EA,EO.0) GOTO 511
C      OBUJUF(1) = OPUKEL,OR,((OP2EA-1)*10),OR,OP2DA
C      GOTO 6000
C      511 CALL PROCOP(OPMPT2)
C      514 OBUJUF(2) = OPNWD(2)
C      IF(OPNWD,EO.2) OBUJUF(2) = OPNWD(3)
C      IF(OPNWD,EO.2) OBUJUF(3) = OPNWD(2)
C      OBUJC = OBUJC+OPNWD
C      OBUJUF(1) = OPUKEL,OR,OPNWD(1)
C      GOTO 6000
C      C,....
C      GENERATE <EA>,DM
C      OPUKEL = OPUKEL,OR,(OP2DA*1000)
C      IF(OP1EA,EO.0) GOTO 522
C      OBUJUF(1) = OPUKEL,OR,((OP1EA-1)*10),OR,OP1DA
C      GOTO 6000
C      522 CALL PROCOP(OPMPT2)
C      GOTO 514
C      C,....
C      GENERATE <EA>,AM
C      525 IF (INODE,EO.1) GOTO 8500
C      IF (INODE,EO.3) OPUKEL = OPUKEL,OR, *500
C      IF ((INODE,EO.2),OR,(INODE,EO.0)) OPUKEL = OPUKEL,OR, *200
C      OPUKEL = OPUKEL,OR, (OP2DA*1000)
C      IF((OP1EA,EO.0),OR,(OP1EA,EO.6)) GOTO 522
C      OBUJUF(1) = OPUKEL,OR,((OP1EA-1)*10),OR,OP1DA
C      GOTO 6000
C      C,....
C      GENERATE XXXI
C      530 IF(OP2EA,GT.6) GOTO 8500
C      C,....
C      EVALUATE IMMEDIATE EXPRESSION
C      CALL PROCOP(OPMPT2)
C      TRY GENERATING SHORT FORM OF INSTRUCTION
C      AFTER CHECKING TO SEE IF OPERAND WAS FWD REF
C      IF(OPNFG,EO.1) GOTO 536
C      IF(OPNWD(2),GE.1,AND,OPNWD(2),LE.8) GOTO 550
C      C,....
C      GENERATE EXTENSION WORDS
C      LENGTH OF OPERAND DEPENDS ON THE INODE OF INSTRUCTION
C      OBUJUF(2) = OPNWD(2)
C      IF(OPNWD,EO.2)OBUJUF(2) = OPNWD(3)
C      IF(OPNWD,EO.2)OBUJUF(3) = OPNWD(2)
C      OBUJC = OBUJC + OPNWD
C      537

```



```

C
305  C.....  OBJBUF(1)=((OP1EA-1)*10).OR.(OP1DA)
C
C.....  CHK FOR SIMPLE SECOND OPERANDS
C
310  C.....  IF (OP2EA.EQ.0) GOTO 315
C
C.....  CHK FOR SR,CCR,USP
C
C.....  IF (OP2EA.GT.6) GOTO 340
C
C.....  GOTO 320
C
C.....  CALCULATE COMPLEX SECOND OPN
C
315  C.....  CALL PROCOP(OPNPT2)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(OBJJNC+2)=OPNARD(2)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(OBJJNC+1)=OPNARD(3)
C
C.....  OBJJNC=OBJJNC+OPNMC
C
C.....  I=(OPNARD(1).AND.7)*10
C
C.....  J=(OPNARD(1).AND.*70)/8
C
C.....  OBJBUF(1)=OBJBUF(1).OR.((I+J)*100).OR.*30000
C
C.....  GOTO 325
C
C.....  PROCESS EA TYPES 0-5 FOR SECOND OPN
C
320  C.....  OBJBUF(1)=OBJBUF(1)+((OP2EA-1).OR.(OP2DA*10)*100).OR.*50000
C
C.....  ADD IN SIZE BITS
C
325  C.....  IF (INDOE.EQ.1) OBJBUF(1)=OBJBUF(1).AND.*17777
C
C.....  IF (INDOE.EQ.3) OBJBUF(1)=OBJBUF(1).AND.*27777
C
C.....  GOTO 7000
C
C.....  GEN MOVED ALSO CLR SIZE BITS IF SET
C
330  C.....  OBJBUF(1) = 0
C
C.....  OBJBUF(1) = (OPNARD(2).AND.*377).OR.*70000.OR.(OP2DA*1000)
C
C.....  GOTO 7000
C
C.....  GENERATE MOVE <EA>,SR - <EA>,CCR - AM,USP
C
340  C.....  IF (OP2EA.EQ.7) OBJBUF(1)=*43300
C
C.....  IF (OP2EA.EQ.8) OBJBUF(1)=*42300
C
C.....  IF (OP2EA.EQ.9) GOTO 342
C
C.....  OBJBUF(1) = *47140.OR.OP1DA
C
C.....  GOTO 7000
C
C.....  GET MIN-REG EA'S IF 0 OR 6
C
342  C.....  IF (OP1EA.EQ.0.OR.OP1EA.EQ.6) GOTO 349
C
C.....  ELSE JUST ADD OR IN THE EA AND REG
C
C.....  OBJBUF(1)=OBJBUF(1).OR.OP1DA.OR.((OP1EA-1)*10)

415  C.....  CALL PROCOP(OPNPTX)
C
C.....  OBJBUF(1) = OPSKEL.OR.(OP2DA*1000).OR.(OPNARD(1).AND.*77)
C
C.....  OBJBUF(2)=OPNARD(2)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(2)=OPNARD(3)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(3)=OPNARD(2)
C
C.....  OBJJNC=OBJJNC+OPNMC
C
C.....  GOTO 6000
C
C.....  CMPI INSTRUCTION
C
C.....  EVALUATE THE IMMEDIATE PART
C
460  C.....  CALL PROCOP(OPNPTX)
C
C.....  OBJJNC = OBJJNC + OPNMC
C
C.....  OBJBUF(2)=OPNARD(2)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(2) = OPNARD(3)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(3) = OPNARD(2)
C
C.....  CHECK FOR SIMPLE DESTINATION EA
C
C.....  IF ((OP2EA.GT.0).AND.(OP2EA.LT.6)) GOTO 470
C
C.....  IF (OP2EA.GT.6) GOTO 8500
C
C.....  CALL PROCOP(OPNPT2)
C
C.....  OBJBUF(1) = OPSKEL.OR.(OPNARD(1).AND.*77)
C
C.....  OBJBUF(OBJJNC+1) = OPNARD(2)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(OBJJNC+1) = OPNARD(3)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(OBJJNC+2) = OPNARD(2)
C
C.....  OBJJNC = OBJJNC+OPNMC
C
C.....  GOTO 6000
C
C.....  SECOND EA IS NOT COMPLEX
C
470  C.....  OBJBUF(1) = OPSKEL.OR.OP2DA.OR.((OP2EA-1)*10)
C
C.....  GOTO 6000
C
C.....  CMPI (AY)+,(AX)+
C
480  C.....  OBJBUF(1)=OPSKEL+(OP2DA*1000+OP1DA)
C
C.....  GOTO 6000
C
C.....  ++++++
C
C.....  PROCESS ADD,SUB INSTRUCTIONS
C
C.....  <EA>,DN <EA>,AN <EA> DATA,<EA>
C
C.....  ++++++
C
C.....  IF (OP2EA.EQ.2) GOTO 525
C
C.....  IF (OP1EA.EQ.6) GOTO 530
C
C.....  IF (OP1EA.EQ.1.OR.OP2EA.EQ.1) GOTO 510
C
C.....  GOTO 8500
C
C.....  ! ALL OTHERS ILLEGAL
C
510  C.....  IF (OP2EA.EQ.1) GOTO 520
C
C.....  OPSKEL = OPSKEL .OR. *100
C
520  C.....  IF (OP2EA.EQ.1) GOTO 520
C
C.....  OPSKEL = OPSKEL .OR. *100

530  C.....  IF (OP2EA.EQ.0) GOTO 540
C
C.....  OBJBUF(1)=OPSKEL.OR.((OP2EA-1)*10).OR.OP2DA
C
C.....  GOTO 6000
C
C.....  EVAL MIN-REG DEST
C
540  C.....  CALL PROCOP(OPNPT2)
C
C.....  OBJJNC = OBJJNC + OPNMC
C
C.....  OBJBUF(1) = OPSKEL.OR.OPNARD(1)
C
C.....  IF (OPNMC.EQ.1) OBJBUF(OBJJNC) = OPNARD(2)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(OBJJNC+1) = OPNARD(3)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(OBJJNC) = OPNARD(2)
C
C.....  GOTO 6000
C
C.....  GENERATE xxxx
C
550  C.....  IF (OPNARD(2).EQ.8) OPNARD(2) = 0
C
C.....  IF (OPSKEL.EQ.*2000) OPSKEL = *50400
C
C.....  IF (OPSKEL.EQ.*3000) OPSKEL = *50000
C
C.....  OPSKEL = OPSKEL.OR.(OPNARD(2)*1000)
C
C.....  GOTO 538
C
C.....  ++++++
C
C.....  PROCESS AND/OR INSTRUCTIONS
C
C.....  <EA>,DN <EA> DATA,<EA>
C
C.....  ++++++
C
C.....  IF (OP1EA.EQ.6) GOTO 610
C
C.....  IF (OP2EA.EQ.1) GOTO 620
C
C.....  PROCESS <EA>,DN
C
C.....  OPSKEL=OPSKEL+(OP2DA*1000)
C
C.....  IF (OP1EA.EQ.0) GOTO 605
C
C.....  OBJBUF(1)=OPSKEL.OR.OP1DA.OR.((OP1EA-1)*10)
C
C.....  GOTO 6000
C
C.....  CALL PROCOP(OPNPTX)
C
C.....  OBJBUF(1)=OPSKEL.OR.OPNARD(1)
C
C.....  OBJBUF(2)=OPNARD(2)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(2)=OPNARD(3)
C
C.....  IF (OPNMC.EQ.2) OBJBUF(3)=OPNARD(2)
C
C.....  OBJJNC=OBJJNC+OPNMC
C
C.....  GOTO 6000
C
C.....  PROCESS DATA,<EA>
C
610  C.....  OPSKEL = OPSKEL
C
C.....  IF (OP2EA.EQ.6) GOTO 8500
C
C.....  CALL PROCOP(OPNPTX)

```

(Continued on next page)

(Continued on page 22, column 3)

(Continued on page 22, column 2)

68000 Cross Assembler (XASM)

(Listing continued, text begins on page 12)

Listing One

```

      OBJBUF(2)=OPNARD(2)
      IF(OPNMC.EQ.2) OBJBUF(2)=OPNARD(3)
      IF(OPNMC.EQ.2) OBJBUF(3)=OPNARD(2)
      OBJMC=OBJMC+OPNMC

```

```

C
C..... NOW THAT WE HAVE IMMEDIATE DATA GET <EA>
C

```

```

      IF(OP2EA.EQ.0.AND.OP1EA.EQ.1) GOTO 6000
      IF(OP2EA.EQ.0) GOTO 615

```

```

C..... CHECK FOR DATA+SR OR DATA+CCR
C

```

```

      IF(OP2EA.LT.7) GOTO 612
      IF(OP2EA.GT.8) GOTO 8500
      IF((INODE.EQ.1).AND.(OP2EA.EQ.8)) GOTO 611
      IF((INODE.EQ.1).OR.(INODE.EQ.3)) GOTO 8500
      OBJBUF(1)=OPSKEL.OR.*74

```

```

611 GOTO 6000
612 OBJBUF(1)=OPSKEL.OR.((OP2EA-1)*10).OR.OP2DA
      GOTO 6000

```

```

C..... EVALUATE <EA> FOR COMPLEX ADDR
C

```

```

615 CALL PROCOP(OPNPT2)
      OBJBUF(OBJMC+1)=OPNARD(2)
630 IF(OPNMC.EQ.2) OBJBUF(OBJMC+1)=OPNARD(3)
      IF(OPNMC.EQ.2) OBJBUF(OBJMC+2)=OPNARD(2)
      OBJMC=OBJMC+OPNMC

```

```

      OBJBUF(1)=OBJBUF(1).OR.OPSKEL
      GOTO 6000

```

```

C..... EVALUATE DM<EA>
C

```

```

620 OPSKEL=OPSKEL+(OP1DA*1000).OR.*400
      IF(OP2EA.EQ.0) GOTO 615
      OBJBUF(1)=OPSKEL.OR.OP2DA.OR.((OP2EA-1)*10)
      GOTO 6000

```

```

C+++++
C

```

```

C..... PROCESS FOR INSTRUCTION
C      DM<EA> DATA<EA>
C

```

```

C+++++
C      IF(OP1EA.EQ.6) GOTO 610
      IF(OP1EA.NE.1) GOTO 8500
      IF(OP2EA.EQ.0) GOTO 620
      OBJBUF(1)=OPSKEL+((OP1EA-1)*1000)+OP2DA+((OP1EA-1)*10)

```

(Continued on column 2)

```

      GOTO 6000
C+++++
C
C..... PROCESS ROTATES AND SHIFTS
C      DX+DY DATA+DY <EA>
C

```

```

C+++++

```

```

800 IF(OP1EA.EQ.1.AND.OP2EA.EQ.1) GOTO 810
      IF(OP1EA.EQ.6.AND.OP2EA.EQ.1) GOTO 820
      IF(OP1EA.EQ.0.AND.OP2EA.EQ.1) GOTO 820

```

```

C..... PROCESS <EA>
C

```

```

      IF(OP1EA.EQ.0) GOTO 801
      IF(OP1EA.LT.3.OR.OP1EA.GT.5) GOTO 8500
      OBJBUF(1)=OPSKEL+((OP1EA-1)*10)+OP1DA
      GOTO 7000

```

```

C..... CALL PROCOP(OPNPT2)
      OBJBUF(1)=OPSKEL+OPNARD(1)
      OBJBUF(2)=OPNARD(2)
      IF(OPNMC.EQ.2) OBJBUF(2)=OPNARD(3)
      IF(OPNMC.EQ.2) OBJBUF(3)=OPNARD(2)
      OBJMC=OBJMC+OPNMC
      GOTO 7000

```

```

C..... OBJBUF(1)=OPSKEL.OR.*40.OR.(OP1DA*1000).OR.OP2DA
      GOTO 6000

```

```

820 CALL PROCOP(OPNPT2)
      IF(OPNARD(2).LT.1.OR.OPNARD(2).GT.8) GOTO 8500
      IF(OPNARD(2).EQ.8) OPNARD(2)=0
      OBJBUF(1)=OPSKEL+OPNARD(2)*1000+OP2DA
      GOTO 6000

```

```

C+++++
C

```

```

C..... PROCESS BRANCH INSTRUCTIONS
C      <LABEL>
C

```

```

C+++++
900 IF(OPNPT2.EQ.0) GOTO 8500
      IF(OP1EA.NE.0) GOTO 8500
      BRFLG = 1

```

```

C..... GENERATE BRANCH ADDRESS
C

```

```

      CALL PROCOP(OPNPT2)

```

```

C..... CHK FOR FORCED SHORT ADDR MODE
C

```

```

      IF(INODE.EQ.4) GOTO 910

```

```

C..... CHECK FOR FWD REF SYMBOL OR REF BEFORE DEFINITION

```

(Continued on column 3)

```

C..... IF(OPNPL6.EQ.1) GOTO 905
C..... CHECK FOR SHORT BRANCH
C
      I = ICKVAL(OPNARD(2))
      IF((I.EQ.0).AND.(OPNARD(2).NE.*177600)) GOTO 910
      IF(INODE.EQ.4) CALL ERROR(404)
      ELSE GENERATE TWO WORD BRANCH
      OBJBUF(1)=OPSKEL
      OBJBUF(2)=OPNARD(2)
      OBJMC = 2
      GOTO 920

```

```

C..... GENERATE SHORT BRANCH
C
910 OBJMC = 1
      OPSKEL=OPSKEL+OPNARD(2).AND.*377)
      OBJBUF(1)=OPSKEL
      BRFLG = 0
      GOTO 7000

```

```

C+++++
C..... PROCESS BIT MODIFICATION INSTRUCTIONS
C      DM<EA> DATA<EA>
C

```

```

C+++++
1000 IF(OP1EA.EQ.1.OR.OP1EA.EQ.6) GOTO 1010
      GOTO 8500
1010 IF(OP1EA.EQ.6) GOTO 1020
      IF(OP2EA.EQ.0) GOTO 1015

```

```

C..... SIMPLE EA'S
C

```

```

      OBJBUF(1)=OPSKEL.OR.(OP1DA*1000).OR.OP2DA
      OBJBUF(1)=OBJBUF(1).OR.((OP2EA-1)*10)
      GOTO 7000

```

```

C..... CALL PROCOP(OPNPT2)
      OBJBUF(2)=OPNARD(2)
      IF(OPNMC.EQ.2) OBJBUF(2)=OPNARD(3)
      IF(OPNMC.EQ.2) OBJBUF(3)=OPNARD(2)
      OBJMC = OBJMC + OPNMC
      OBJBUF(1)=OPSKEL.OR.OPNARD(1).OR.(OP1DA*1000)
      GOTO 7000

```

```

C..... CALL PROCOP(OPNPT2)
      IF(OPNARD(3).NE.0) GOTO 8500
      OBJBUF(2)=OPNARD(2)

```

(Continued next month.)

The Portable Pidgin

Z80 Macro-Assembly Implementation

When in doubt, write in a machine-independent language. Anyone who has seen a cherished program lie fallow for lack of portability will recognize the wisdom of this maxim. Yet machine-independent languages are normally high-level affairs ill-suited for supporting the compact code and rapid execution times required of many systems programs. Whence my excitement upon learning of William Gale's *Pidgin*, a low-level, structured, portable programming language (DDJ #57). I suspect that Dr. Gale's compiler generator Meta4 (DDJ #58) is only the first of many powerful systems programs that will be written in the flexible format of *Pidgin*.

by Herbert Gintis

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Pidgin is portable because it was designed to be supported by a portable compiler. Indeed, Dr. Gale has provided us with *Tincmp*, a *Pidgin* compiler written in *Pidgin* itself, yet organized to facilitate its relatively easy implementation on any machine. But only relatively! What I shall suggest here is that *Tincmp* can be implemented with little difficulty on any machine for which a reasonably powerful macro-assembler exists. The example presented here uses a Z80 microprocessor running under CP/M, and the macroprocessor is *Venus*, a structured editor-assembler-linker-symbolic debugger which I've developed over the past year.

The strategy for implementing *Tincmp* is straightforward: generate an assembly-language version of the compiler by translating each and every *Pidgin* statement into a macro.

The result of this exercise is a new *Tincmp* source file which I have called

Tinsource, shown in Listing 2, and a source file of macros called *Tinmacro*, shown in Listing 1. I shall discuss these two source files in turn.

Since *Venus* uses standard assembly-language pseudo-ops (e.g., CP/M's ASM-COM), *Tinsource* should be easy to understand, subject to the following notes. First, *Venus* uses the pseudo-op INCBG <filename.filetype> to instruct the assembler to include the specified file at the beginning of the source code before assembly. In this case, *Tinmacro* will be so included. Second, a string of one to five alphanumeric characters beginning with a letter, occurring where *Venus* expects a mnemonic opcode or pseudo-op, and followed by an exclamation point (!), is treated as a macro call.

The meaning of the macros is either the same as that of the corresponding *Pidgin* statement, is indicated in the remarks, or can be inferred by comparing *Tinsource* with *Tincmp*. I have attempted to use obvious mnemonics where possible. Thus "B" stands for "byte", "I" for "int", "E" for "set equal to", "O" for "or", "A" for "and", "EE" for "is equal to", "LE" for "is less than or equal to", and so forth.

Since *Venus* is a structured assembler, I in fact implemented the control statements WHILE-ON-ENDWHILE and IF-ELSE-ENDIF directly. However, since structured facilities are rare in assemblers, I have rewritten *Tinsource* by treating these control statements as program labels. Thus a WHILE becomes the string "WH" followed by a number, and ENDWHILE becomes "NDWH" followed by a number. The ON in the WHILE-ENDWHILE construction is translated into the macro IFNOT, which moves beyond the ENDWHILE if the condition tested is false. The IF-ELSE-ENDIF is similarly treated, using the common beginning string IF followed by a number. The CHOOSE ON-CASE construction is directly implemented as a macro.

Tinmacro, given in Listing 1 is also by and large self-explanatory. The macro-processor of *Venus* is fairly standard. The name of the macro is written in the label column followed by the pseudo-op MACRO, followed in turn by a list of the prototype variables separated by commas. A proto-type variable is preceded by the ampersand (&). The period (.) is a non-printed string terminator.

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Thus if the macroprocessor encounters the line

```
LD HL, (I.&DEST)
```

and the current value of &DEST is GG, the line will be expanded as

```
LD HL, (IGG)
```

Tinmacro is organized according to the principle that each byte variable in the object code generated (which is in this case an assembly source file) is preceded by the string BB, and each integer variable is preceded by the single letter I. By comparing the listing of Tinmacro with the 8080A macros suggested by Andrew Bender (*DDJ* #65 - March 1982), the reader will notice that I have streamlined some of the coding, using the fact that the Z80 accumulator can be loaded without altering the flag conditions.

To implement Tincmp for your machine, alter Tinmacro and Tinsource to meet the conventions of your assembler.

If you do not have a pseudo-op like INCBG, then Tinmacro will have to be merged directly with Tinsource, an easy task on a text editor. If you do not have a macroprocessor, you are probably out of luck, since the full source code of Tinsource with all macros expanded would probably run some 4000 lines.

When Tinsource assembles without errors, then you must implement the Tincmp macros, following the example of Bender's, perhaps with the streamlining suggested in Listing 1. Note that Bender's implementation of the structured control statements uses multiple ORG's, which are disliked by some relocating assemblers. Venus does not mind such multiple ORG's, but there is an easy alternative strategy which I have successfully tested anyway.

The problem arises with the CHOOSE ON \$\$ and CASE \$\$ statements in Pidgin. Unlike the C language, Pidgin does not allow a program to "fall through" to

the next CASE upon the execution of one CASE, but rather demands exiting the control structure. Thus in generating the assembly source code for the CASE \$\$ statement, the first line must be a jump over any remaining CASE \$\$ statements. However, this jump must be suppressed in the *first* such statement after the CHOOSE ON \$. The strategy for handling this is to have the CHOOSE ON \$\$ place a comment symbol (;) on the top of the stack, and have each CASE \$\$ immediately place the top of the stack in the destination file, and replace it with a blank (), which will be ignored by the assembler. The relevant Tincmp macros will then be:

```
:CHOOSE ON $;
LD A, (BB↑P1C↑P2C);
LD HL, ERASER;
LD (HL), A↑U0S↑L@; S↑U1S;
:CASE $;
↑!0P↑!9P↑!8P;
↑P9CJP NDCH↑P0N;
CS↑P8N LD A, (BB↑P1C↑P2C);
CP (HL);
JP NZ, CS↑U1S↑S8N↑L@ S↑POS;
```

The final step in implementing Tincmp involves developing the system utilities, including the algebraic routines ICOMP, ISUB, CDEHL, IMUL, and IDIV, as well as the CP/M input-output routines START, BREAD, BWRITE, PRT, IOPEN, MSG, CONOUT, and BCLOSE. The requirements for the algebraic routines are well-described in Bender's excellent article. CONOUT is essentially CP/M's Direct Consol I/O (Function 6), but preserving all registers. PRT uses CONOUT to output the string pointed to by the HL register; the string must terminate with a carriage return (0dh in ASCII). MSG is the same as PRT, except that precisely 9 characters are transmitted. The I/O routines must be written using the system utilities associated with your assembler. Their functions, will be obvious from the places in Listing 1 where they are used, after a careful reading of the discussion of these routines in Bender's article.

DDJ

(Listing begins at right)

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Listing One

```

(A:TINMACRO)11 11, f
1 * *****
2 * TINMACRO *****
3 *
4 * *****
5 *
6 * Listing 1
7 *
8 * *****
9 *
10 * Macros for the implementation of TINSOURCE
11 *
12 IIEI MACRO &A, &B, &C ; I$$=I$$+I$$
13 LD HL, (I, &B)
14 LD DE, I, &A
15 ADD HL, HL
16 EX DE, HL
17 LD HL, (I, &C)
18 LD A, L
19 LD (DE), A
20 INC DE
21 LD A, H
22 LD (DE), A
23 MEND
24 IINC MACRO &A ; I$$++
25 LD HL, (I, &A)
26 INC HL
27 LD (I, &A), HL
28 MEND
29 BIEB MACRO &A, &B, &C ; I$$=I$$+I$$
30 LD HL, (I, &B)
31 LD DE, &B, &A
32 ADD HL, DE
33 LD A, (BB, &C)
34 LD (HL), A
35 MEND
36 BTNC MACRO &A ; I$$++
37 LD HL, &B, &A
38 INC (HL)
39 MEND
40 BBEB MACRO &A, &B, &C ; I$$=I$$+I$$
41 LD HL, (BB, &B)
42 LD H, 0
43 LD DE, &B, &A
44 ADD HL, DE
45 LD A, (BB, &C)
46 LD (HL), A
47 MEND
48 REEB MACRO &A, &B, &C ; I$$=I$$+I$$
49 LD HL, (BB, &C)
50 LD H, 0
51 LD DE, &B, &B
52 ADD HL, DE
53 LD A, (HL)
54 LD (BB, &A), A
55 MEND
56 IEIPI MACRO &A, &B, &C ; I$$=I$$+I$$
57 LD HL, (I, &B)
58

```

```

LD DE, (I, &C)
LD HL, DE
LD (I, &A), HL
MEND
62 IIEI MACRO &A, &B, &C ; I$$=I$$+I$$
63 LD HL, (I, &C)
64 LD DE, I, &B
65 ADD HL, HL
66 ADD HL, DE
67 LD E, (HL)
68 INC HL
69 LD D, (HL)
70 EX DE, HL
71 LD (I, &A), HL
72 MEND
73 BEBI MACRO &A, &B, &C ; I$$=I$$+I$$
74 LD HL, (I, &C)
75 LD DE, &B, &B
76 ADD HL, DE
77 LD A, (HL)
78 LD (BB, &A), A
79 MEND
80 BEB MACRO &A, &B ; I$$=I$$
81 LD A, (BB, &B)
82 LD (BB, &A), A
83 MEND
84 IEI MACRO &A, &B ; I$$=I$$
85 LD HL, (I, &B)
86 LD (I, &A), HL
87 MEND
88 BECON MACRO &A, &B ; I$$=I$$+I$$
89 LD A, &B
90 LD (BB, &A), A
91 MEND
92 IECON MACRO &A, &B ; I$$=I$$+I$$+I$$
93 LD HL, &B
94 LD (I, &A), HL
95 MEND
96 BEBEB MACRO &A, &B, &C ; I$$=I$$+I$$
97 LD HL, &B, &C
98 LD A, (BB, &B)
99 LD A, (HL)
100 LD (BB, &A), A
101 MEND
102 REEBMB MACRO &A, &B, &C ; I$$=I$$+I$$
103 LD HL, &B, &C
104 LD A, (BB, &B)
105 SUB (HL)
106 LD (BB, &A), A
107 MEND
108 REEB MACRO &A, &B, &C ; I$$=I$$+I$$
109 LD HL, &B, &C
110 LD A, (BB, &B)
111 AND (HL)
112 LD (BB, &A), A
113 MEND
114 BEBOB MACRO &A, &B, &C ; I$$=I$$+I$$
115 LD HL, &B, &C
116 LD A, (BB, &B)
117 OR (HL)
118 LD (BB, &A), A
119 MEND
120 IEMI MACRO &A, &B ; I$$=I$$+I$$
121 LD HL, (I, &B)
122 ICOMP
123 CALL (I, &A), HL
124

```

(Continued on next page)

(Continued on column 2)

Tinmacro (Listing continued, text begins on page 25)

Listing One (Continued)

```

125 ICOMP      EXTRN
126           MEND
127 IEIMI       MACRO      &A, &B, &C      ; I$$=I$$-I$$
128           LD          HL, (I.&C)
129           EX          DE, HL
130           LD          HL, (I.&B)
131           CALL        ISUB
132           LD          (I.&A), HL
133 ISUB        EXTRN
134           MEND
135 INEI        MACRO
136           LD          DE, I.&IBB
137           LD          HL, I.&IAA
138           CALL        INTCK
139           LD          (BB.&BB), A
140 INTCK       EXTRN
141           MEND
142 ILEI        MACRO      &BB, &IAA, &IBB      ; I$$=I$$ (=I$$
143           LD          HL, (I.&IBB)
144           EX          DE, HL
145           LD          HL, (I.&IAA)
146           CALL        CDEHL
147 CDEHL      EXTRN
148           CALL        SETAC
149 SETAC      EXTRN
150           LD          (BB.&BB), A
151           MEND
152 BYTE        MACRO      &BB      ; BYTE $$
153           RAM
154 BB.&BB      DS          1
155           REL
156           MEND
157 INT         MACRO      &IAA      ; INT I$$
158           RAM
159 I.&IAA      DS          2
160           REL
161           MEND
162 BYTER       MACRO      &B*, &NNN      ; BYTE $$(($$) OR BYTE $$(($$($$)
163           RAM
164 BB.&B1      DS          &NNN
165           REL
166           MEND
167 INTI        MACRO      &IAA, &NNN      ; INT I$$(($$($$($$)
168           RAM
169 I.&IAA      DS          2 * &NNN
170           REL
171           MEND
172 GOSUB       MACRO
173           CALL        SUB.&ROUTINE
174           MEND
175 STOP        MACRO
176           HL, $+6
177           CALL        PRN
178           JP          0000
179           DB          'STOP ON ', &N+10, ':D
180           MEND
181 ISLI        MACRO      &BB, &IAA, &IBB      ; I$$=I$$(I$$
182           LD          HL, (I.&IBB)
183           EX          DE, HL
184           LD          HL, (I.&IAA)
185           CALL        CDEHL
186           EXTRN
187           RLA

```



```

188 AND
189 LD (BB.&BB),A
190 MEND
191 MACRO
192   &CC,&F1 ;READ $$ FROM $$
193   HL, BB.&CC
194   DE, BB.&F1
195   BREAD
196   EXTRN
197   MEND
198   MACRO
199     &CC,&F1 ;WRITE $$ INTO $$
200     A, (BB.&CC)
201     DE, BB.&F1
202     BWRITE
203     A, (ER)
204     OR A
205     NZ, PRT
206     CALL EXTRN
207     MEND
208     MACRO
209       &F1,&RW,&INM ;OPEN $$ FOR $$ AT I$$
210       DE, BB.&F1
211       A, (BB.&RW)
212       HL, (I.&INM)
213       IOPEN
214       A, (ER)
215       OR A
216       NZ, PRT
217       CALL EXTRN
218       MEND
219       MACRO
220         &STRING ;PRINT 9 CHARS
221         HL,$+5
222         MSG
223         EXTRN
224         JR DB
225         MS.&XX,FF
226         &STRING
227         MEND
228         MACRO
229           &B1,&B2,&B3 ;$$=$$!=$$
230           HL, BB.&B3
231           A, (BB.&B2)
232           (HL)
233           A, 0
234           Z, 1
235           INC A
236           (BB.&B1),A
237           MEND
238           MACRO
239             &B1,&B2,&B3 ;$$=$$=$$
240             HL, BB.&B3
241             A, (BB.&B2)
242             (HL)
243             A, 1
244             Z, 1
245             XOR A
246             (BB.&B1),A
247             MEND
248             MACRO
249               &IAA,&B1 ;I$$=$$
250               A, (BB.&B1)
251               L,A
252               H,0
253               (I.&IAA),HL
254               MEND
255               MACRO
256                 &B1,&B2,&B3 ;$$=$$($$)
257                 A, (BB.&B2)
258                 HL, BB.&B3

```

```

322 LD A,H
323 (BB.&B2),A
324 MEND
325 MACRO
326   &B1,&IAA,&IBB ;$$=I$$=I$$
327   HL, (I.&IAA)
328   DE, (I.&IBB)
329   CDEHL
330   A, 1
331   Z, 1
332   XOR A
333   (BB.&B1),A
334   EXTRN
335   MEND
336   MACRO
337     &NN ;GOTO $$
338     LOC.&NN
339     JP
340     MEND
341     MACRO
342       &B1 ;WRITE $$
343       A, (BB.&B1)
344       CONOUT
345       MEND
346       MACRO
347         &B1 ;CLOSE $$
348         HL, BB.&B1
349         BCLOSE
350         A, (ER)
351         LD A
352         OR A
353         NZ, PRT
354         CALL EXTRN
355         MEND
356         MACRO
357           &B1 ;CHON
358           A, (BB.&B1)
359           LD A
360           MEND
361           MACRO
362             &B1,&DEST ;GOTO DEST IF B1 FALSE
363             A, (BB.&B1)
364             LD A
365             OR A
366             Z,&DEST
367             MEND
368             MACRO
369               &B1,&DEST ;GOTO DEST IF (A) = (B1)
370               HL, BB.&B1
371               CP (HL)
372               NZ,&DEST
373               JP MEND
374               (A,TINMACRO)ff

```

Tinsource Listing Two

```

(A:TINMACRO)P
(A:TINDMP)1: 11,f
1 * ***** TINSOURCE *****
2 *
3 *
4 * *****
5 *
6 * LISTING 2
7 *
8 * *****
9 *
10 * The TINDMP Compiler in Assembly Language
11 *
12 *
13 UNLST ; suppress printer listing
14 INCBG TINMACRO ; append TINMACRO here
15 LIST ; resume printer listing

```


Tinsource (Listing continued, text begins on page 25)

Listing Two (Continued)

```

15 ER          XMAC
16 EXTRN      EDU      ER
17 BBER      BYTE! AA
18          BYTE! BB
19          BYTE! DD
20          BYTE! EE
21          BYTE! BF,080
22          BYTE! BL
23          BYTE! BP
24          BYTE! C0
25          BYTE! C1
26          BYTE! C2
27          BYTE! C3
28          BYTE! C4
29          BYTE! C8
30          BYTE! C9
31          BYTE! CC
32          BYTE! CX
33          *
34          BYTE! DG
35          BYTE! DS,10
36          BYTE! EF
37          BYTE! F1,120
38          BYTE! F2,128
39          BYTE! HA
40          BYTE! HF
41          BYTE! LE
42          BYTE! LF
43          BYTE! LS,3000
44          BYTE! MF
45          BYTE! ML
46          BYTE! MM
47          *
48          BYTE! ND
49          BYTE! NL
50          BYTE! O1
51          BYTE! O2
52          BYTE! O3
53          BYTE! OA
54          BYTE! OB
55          BYTE! OC
56          BYTE! OD
57          BYTE! DE
58          BYTE! OG
59          BYTE! OH
60          BYTE! OL
61          BYTE! OM
62          BYTE! ON
63          *
64          BYTE! OP
65          BYTE! OR
66          BYTE! OS
67          *
68          BYTE! OT
69          BYTE! PP
70          BYTE! RB
71          BYTE! RC
72          BYTE! SF
73          BYTE! SP
74          BYTE! TR
75          BYTE! UG
76          BYTE! UN
77          BYTE! UD
78          *

; suppress the printing of macro expansion
; all byte variables begin with BB
;WORK
;WORK
;WORK
;WORK
;EXPANSION BUFFER
;BLANK
;PTR INTO BF
;0
;1
;2
;3
;40
;80
;9
;INPUT CHAR
;10

;DIGIT FROM PARAMETER DEF
;DIGIT STACK FOR SUB SD
;END OF FILE MARK
;INPUT BUFFER
;OUTPUT BUFFER
;'A'
;'F'
;END OF LIST
;LINE FEED CHAR
;LIST OF MACRO DEFS
;MACRO REPLACEMENT OPERATOR FLAG
;MACRO LENGTH
;MIN. MACRO LENGTH

;# OF DIGITS IN SD OUTPUT
;NEW LINE
;FETCH CODE
;INDEX CODE
;DISPOSE CODE
;'+' OPERATOR
;'-' OPERATOR
;'C' CHAR. DISPOSE OPERATOR
;'V' DIGIT CONV. FETCH
;ESC CHAR
;'H' HEX CONV. FETCH
;'L' LITERAL FETCH
;'BYTE' * MULT DISPOSE
;'N' NUMERIC LITERAL FETCH

;'P' PARAMETER FETCH OR DISPOSE
;'-' REDUCE (SUBTRACT) DISPOSE
;'S' STACK FETCH OR DISPOSE

;TRACE FLAG
;PTR INTO IPR
;BEGIN DEF. FLAG
;END OF LINE (COMMENT) FLAG
;SUBS. PARAMETER FLAG
;STACK PTR
;TRUE IF NO TRACE
;USE IGNORE: TRUE UNLESS OG='X'
;FLAG FOR NOT SUPPRESSING NEW LINESON OUTPUT
;USE OPERATIONS; TRUE UNLESS MF='X'

```


Tinsource (Listing continued, text begins on page 25)

Listing Two (Continued)

```

282      BEB! RC,CC
283      GOSUB! GI
284      BEB! SF,CC
285      GOSUB! GI
286      BEB! MF,CC
287
288 * Set UD true iff expansion flag is not 'X'
289
290      BECON! BB,'X'
291      BEB! AA,MF,BB
292      IFNOT! AA,IF1
293      BEB! UD,C0
294      JR IF2
295      BEB! UD,C1
296      IF2
297
298      BECON! OP,'P'
299      BECON! DE,'@'
300      BECON! OD,'V'
301      BECON! OS,'S'
302      BECON! OH,'H'
303      BECON! ON,'N'
304      BECON! OL,'L'
305      BECON! OC,'C'
306      BECON! OA,'+'
307      BECON! OR,'-'
308      BECON! OM,'*'
309      GOSUB! GI
310      BEB! OG,CC
311      BECON! AA,'X'
312      BEB! BB,AA,OG
313      IFNOT! BB,IF3
314      BECON! UG,0
315      JR IF4
316      BECON! UG,1
317      IF4
318
319      GOSUB! GI
320      BEB! AA,NL,CC
321      IFNOT! AA,IF5
322      MS! 'FLAG LINE'
323      STOP! 1
324      BECON! IUU,100
325      RET
326
327 * Read Macros
328
329      SUBRM
330
331      IEI! I11,100
332      IEI! INM,C0
333      BECON! MM,127
334
335      GOSUB! GI
336      BEB! AA,ER,C0
337      IFNOT! AA,NDWH1
338      CHSON! CC
339      CASE! DE,CS1
340      GOSUB! GI
341      JR LOC77
342      CASE! RB,CS2
343      IEI! ILP,INM,I11
344      IEI! INM
345      BECON! ML,0
346      JR NDCH1
347      CASE! NL,CS2A
348      JR NDCH1
349
350      BECON! BB,'X'
351      BEB! AA,MF,BB
352      IFNOT! AA,IF1
353      BEB! UD,C0
354      JR IF2
355      BEB! UD,C1
356      IF2
357
358      BECON! OP,'P'
359      BECON! DE,'@'
360      BECON! OD,'V'
361      BECON! OS,'S'
362      BECON! OH,'H'
363      BECON! ON,'N'
364      BECON! OL,'L'
365      BECON! OC,'C'
366      BECON! OA,'+'
367      BECON! OR,'-'
368      BECON! OM,'*'
369      GOSUB! GI
370      BEB! OG,CC
371      BECON! AA,'X'
372      BEB! BB,AA,OG
373      IFNOT! BB,IF3
374      BECON! UG,0
375      JR IF4
376      BECON! UG,1
377      IF4
378
379      GOSUB! GI
380      BEB! AA,NL,CC
381      IFNOT! AA,IF5
382      MS! 'FLAG LINE'
383      STOP! 1
384      BECON! IUU,100
385      RET
386
387 * Read Macros
388
389      SUBRM
390
391      IEI! I11,100
392      IEI! INM,C0
393      BECON! MM,127
394
395      GOSUB! GI
396      BEB! AA,ER,C0
397      IFNOT! AA,NDWH1
398      CHSON! CC
399      CASE! DE,CS1
400      GOSUB! GI
401      JR LOC77
402      CASE! RB,CS2
403      IEI! ILP,INM,I11
404      IEI! INM
405      BECON! ML,0
406      JR NDCH1
407      CASE! NL,CS2A
408      JR NDCH1
409
410      BECON! BB,'X'
411      BEB! AA,MF,BB
412      IFNOT! AA,IF1
413      BEB! UD,C0
414      JR IF2
415      BEB! UD,C1
416      IF2
417
418      BECON! OP,'P'
419      BECON! DE,'@'
420      BECON! OD,'V'
421      BECON! OS,'S'
422      BECON! OH,'H'
423      BECON! ON,'N'
424      BECON! OL,'L'
425      BECON! OC,'C'
426      BECON! OA,'+'
427      BECON! OR,'-'
428      BECON! OM,'*'
429      GOSUB! GI
430      BEB! OG,CC
431      BECON! AA,'X'
432      BEB! BB,AA,OG
433      IFNOT! BB,IF3
434      BECON! UG,0
435      JR IF4
436      BECON! UG,1
437      IF4
438
439      GOSUB! GI
440      BEB! AA,NL,CC
441      IFNOT! AA,IF5
442      MS! 'FLAG LINE'
443      STOP! 1
444      BECON! IUU,100
445      RET
446
447 * Read Macros
448
449      SUBRM
450
451      IEI! I11,100
452      IEI! INM,C0
453      BECON! MM,127
454
455      GOSUB! GI
456      BEB! AA,ER,C0
457      IFNOT! AA,NDWH1
458      CHSON! CC
459      CASE! DE,CS1
460      GOSUB! GI
461      JR LOC77
462      CASE! RB,CS2
463      IEI! ILP,INM,I11
464      IEI! INM
465      BECON! ML,0
466      JR NDCH1
467      CASE! NL,CS2A
468      JR NDCH1
469
470      BECON! BB,'X'
471      BEB! AA,MF,BB
472      IFNOT! AA,IF1
473      BEB! UD,C0
474      JR IF2
475      BEB! UD,C1
476      IF2
477
478      BECON! OP,'P'
479      BECON! DE,'@'
480      BECON! OD,'V'
481      BECON! OS,'S'
482      BECON! OH,'H'
483      BECON! ON,'N'
484      BECON! OL,'L'
485      BECON! OC,'C'
486      BECON! OA,'+'
487      BECON! OR,'-'
488      BECON! OM,'*'
489      GOSUB! GI
490      BEB! OG,CC
491      BECON! AA,'X'
492      BEB! BB,AA,OG
493      IFNOT! BB,IF3
494      BECON! UG,0
495      JR IF4
496      BECON! UG,1
497      IF4
498
499      GOSUB! GI
500      BEB! AA,NL,CC
501      IFNOT! AA,IF5
502      MS! 'FLAG LINE'
503      STOP! 1
504      BECON! IUU,100
505      RET
506
507 * Read Macros
508
509      SUBRM
510
511      IEI! I11,100
512      IEI! INM,C0
513      BECON! MM,127
514
515      GOSUB! GI
516      BEB! AA,ER,C0
517      IFNOT! AA,NDWH1
518      CHSON! CC
519      CASE! DE,CS1
520      GOSUB! GI
521      JR LOC77
522      CASE! RB,CS2
523      IEI! ILP,INM,I11
524      IEI! INM
525      BECON! ML,0
526      JR NDCH1
527      CASE! NL,CS2A
528      JR NDCH1
529
530      BECON! BB,'X'
531      BEB! AA,MF,BB
532      IFNOT! AA,IF1
533      BEB! UD,C0
534      JR IF2
535      BEB! UD,C1
536      IF2
537
538      BECON! OP,'P'
539      BECON! DE,'@'
540      BECON! OD,'V'
541      BECON! OS,'S'
542      BECON! OH,'H'
543      BECON! ON,'N'
544      BECON! OL,'L'
545      BECON! OC,'C'
546      BECON! OA,'+'
547      BECON! OR,'-'
548      BECON! OM,'*'
549      GOSUB! GI
550      BEB! OG,CC
551      BECON! AA,'X'
552      BEB! BB,AA,OG
553      IFNOT! BB,IF3
554      BECON! UG,0
555      JR IF4
556      BECON! UG,1
557      IF4
558
559      GOSUB! GI
560      BEB! AA,NL,CC
561      IFNOT! AA,IF5
562      MS! 'FLAG LINE'
563      STOP! 1
564      BECON! IUU,100
565      RET
566
567 * Read Macros
568
569      SUBRM
570
571      IEI! I11,100
572      IEI! INM,C0
573      BECON! MM,127
574
575      GOSUB! GI
576      BEB! AA,ER,C0
577      IFNOT! AA,NDWH1
578      CHSON! CC
579      CASE! DE,CS1
580      GOSUB! GI
581      JR LOC77
582      CASE! RB,CS2
583      IEI! ILP,INM,I11
584      IEI! INM
585      BECON! ML,0
586      JR NDCH1
587      CASE! NL,CS2A
588      JR NDCH1
589
590      BECON! BB,'X'
591      BEB! AA,MF,BB
592      IFNOT! AA,IF1
593      BEB! UD,C0
594      JR IF2
595      BEB! UD,C1
596      IF2
597
598      BECON! OP,'P'
599      BECON! DE,'@'
600      BECON! OD,'V'
601      BECON! OS,'S'
602      BECON! OH,'H'
603      BECON! ON,'N'
604      BECON! OL,'L'
605      BECON! OC,'C'
606      BECON! OA,'+'
607      BECON! OR,'-'
608      BECON! OM,'*'
609      GOSUB! GI
610      BEB! OG,CC
611      BECON! AA,'X'
612      BEB! BB,AA,OG
613      IFNOT! BB,IF3
614      BECON! UG,0
615      JR IF4
616      BECON! UG,1
617      IF4
618
619      GOSUB! GI
620      BEB! AA,NL,CC
621      IFNOT! AA,IF5
622      MS! 'FLAG LINE'
623      STOP! 1
624      BECON! IUU,100
625      RET
626
627 * Read Macros
628
629      SUBRM
630
631      IEI! I11,100
632      IEI! INM,C0
633      BECON! MM,127
634
635      GOSUB! GI
636      BEB! AA,ER,C0
637      IFNOT! AA,NDWH1
638      CHSON! CC
639      CASE! DE,CS1
640      GOSUB! GI
641      JR LOC77
642      CASE! RB,CS2
643      IEI! ILP,INM,I11
644      IEI! INM
645      BECON! ML,0
646      JR NDCH1
647      CASE! NL,CS2A
648      JR NDCH1
649
650      BECON! BB,'X'
651      BEB! AA,MF,BB
652      IFNOT! AA,IF1
653      BEB! UD,C0
654      JR IF2
655      BEB! UD,C1
656      IF2
657
658      BECON! OP,'P'
659      BECON! DE,'@'
660      BECON! OD,'V'
661      BECON! OS,'S'
662      BECON! OH,'H'
663      BECON! ON,'N'
664      BECON! OL,'L'
665      BECON! OC,'C'
666      BECON! OA,'+'
667      BECON! OR,'-'
668      BECON! OM,'*'
669      GOSUB! GI
670      BEB! OG,CC
671      BECON! AA,'X'
672      BEB! BB,AA,OG
673      IFNOT! BB,IF3
674      BECON! UG,0
675      JR IF4
676      BECON! UG,1
677      IF4
678
679      GOSUB! GI
680      BEB! AA,NL,CC
681      IFNOT! AA,IF5
682      MS! 'FLAG LINE'
683      STOP! 1
684      BECON! IUU,100
685      RET
686
687 * Read Macros
688
689      SUBRM
690
691      IEI! I11,100
692      IEI! INM,C0
693      BECON! MM,127
694
695      GOSUB! GI
696      BEB! AA,ER,C0
697      IFNOT! AA,NDWH1
698      CHSON! CC
699      CASE! DE,CS1
700      GOSUB! GI
701      JR LOC77
702      CASE! RB,CS2
703      IEI! ILP,INM,I11
704      IEI! INM
705      BECON! ML,0
706      JR NDCH1
707      CASE! NL,CS2A
708      JR NDCH1
709
710      BECON! BB,'X'
711      BEB! AA,MF,BB
712      IFNOT! AA,IF1
713      BEB! UD,C0
714      JR IF2
715      BEB! UD,C1
716      IF2
717
718      BECON! OP,'P'
719      BECON! DE,'@'
720      BECON! OD,'V'
721      BECON! OS,'S'
722      BECON! OH,'H'
723      BECON! ON,'N'
724      BECON! OL,'L'
725      BECON! OC,'C'
726      BECON! OA,'+'
727      BECON! OR,'-'
728      BECON! OM,'*'
729      GOSUB! GI
730      BEB! OG,CC
731      BECON! AA,'X'
732      BEB! BB,AA,OG
733      IFNOT! BB,IF3
734      BECON! UG,0
735      JR IF4
736      BECON! UG,1
737      IF4
738
739      GOSUB! GI
740      BEB! AA,NL,CC
741      IFNOT! AA,IF5
742      MS! 'FLAG LINE'
743      STOP! 1
744      BECON! IUU,100
745      RET
746
747 * Read Macros
748
749      SUBRM
750
751      IEI! I11,100
752      IEI! INM,C0
753      BECON! MM,127
754
755      GOSUB! GI
756      BEB! AA,ER,C0
757      IFNOT! AA,NDWH1
758      CHSON! CC
759      CASE! DE,CS1
760      GOSUB! GI
761      JR LOC77
762      CASE! RB,CS2
763      IEI! ILP,INM,I11
764      IEI! INM
765      BECON! ML,0
766      JR NDCH1
767      CASE! NL,CS2A
768      JR NDCH1
769
770      BECON! BB,'X'
771      BEB! AA,MF,BB
772      IFNOT! AA,IF1
773      BEB! UD,C0
774      JR IF2
775      BEB! UD,C1
776      IF2
777
778      BECON! OP,'P'
779      BECON! DE,'@'
780      BECON! OD,'V'
781      BECON! OS,'S'
782      BECON! OH,'H'
783      BECON! ON,'N'
784      BECON! OL,'L'
785      BECON! OC,'C'
786      BECON! OA,'+'
787      BECON! OR,'-'
788      BECON! OM,'*'
789      GOSUB! GI
790      BEB! OG,CC
791      BECON! AA,'X'
792      BEB! BB,AA,OG
793      IFNOT! BB,IF3
794      BECON! UG,0
795      JR IF4
796      BECON! UG,1
797      IF4
798
799      GOSUB! GI
800      BEB! AA,NL,CC
801      IFNOT! AA,IF5
802      MS! 'FLAG LINE'
803      STOP! 1
804      BECON! IUU,100
805      RET
806
807 * Read Macros
808
809      SUBRM
810
811      IEI! I11,100
812      IEI! INM,C0
813      BECON! MM,127
814
815      GOSUB! GI
816      BEB! AA,ER,C0
817      IFNOT! AA,NDWH1
818      CHSON! CC
819      CASE! DE,CS1
820      GOSUB! GI
821      JR LOC77
822      CASE! RB,CS2
823      IEI! ILP,INM,I11
824      IEI! INM
825      BECON! ML,0
826      JR NDCH1
827      CASE! NL,CS2A
828      JR NDCH1
829
830      BECON! BB,'X'
831      BEB! AA,MF,BB
832      IFNOT! AA,IF1
833      BEB! UD,C0
834      JR IF2
835      BEB! UD,C1
836      IF2
837
838      BECON! OP,'P'
839      BECON! DE,'@'
840      BECON! OD,'V'
841      BECON! OS,'S'
842      BECON! OH,'H'
843      BECON! ON,'N'
844      BECON! OL,'L'
845      BECON! OC,'C'
846      BECON! OA,'+'
847      BECON! OR,'-'
848      BECON! OM,'*'
849      GOSUB! GI
850      BEB! OG,CC
851      BECON! AA,'X'
852      BEB! BB,AA,OG
853      IFNOT! BB,IF3
854      BECON! UG,0
855      JR IF4
856      BECON! UG,1
857      IF4
858
859      GOSUB! GI
860      BEB! AA,NL,CC
861      IFNOT! AA,IF5
862      MS! 'FLAG LINE'
863      STOP! 1
864      BECON! IUU,100
865      RET
866
867 * Read Macros
868
869      SUBRM
870
871      IEI! I11,100
872      IEI! INM,C0
873      BECON! MM,127
874
875      GOSUB! GI
876      BEB! AA,ER,C0
877      IFNOT! AA,NDWH1
878      CHSON! CC
879      CASE! DE,CS1
880      GOSUB! GI
881      JR LOC77
882      CASE! RB,CS2
883      IEI! ILP,INM,I11
884      IEI! INM
885      BECON! ML,0
886      JR NDCH1
887      CASE! NL,CS2A
888      JR NDCH1
889
890      BECON! BB,'X'
891      BEB! AA,MF,BB
892      IFNOT! AA,IF1
893      BEB! UD,C0
894      JR IF2
895      BEB! UD,C1
896      IF2
897
898      BECON! OP,'P'
899      BECON! DE,'@'
900      BECON! OD,'V'
901      BECON! OS,'S'
902      BECON! OH,'H'
903      BECON! ON,'N'
904      BECON! OL,'L'
905      BECON! OC,'C'
906      BECON! OA,'+'
907      BECON! OR,'-'
908      BECON! OM,'*'
909      GOSUB! GI
910      BEB! OG,CC
911      BECON! AA,'X'
912      BEB! BB,AA,OG
913      IFNOT! BB,IF3
914      BECON! UG,0
915      JR IF4
916      BECON! UG,1
917      IF4
918
919      GOSUB! GI
920      BEB! AA,NL,CC
921      IFNOT! AA,IF5
922      MS! 'FLAG LINE'
923      STOP! 1
924      BECON! IUU,100
925      RET
926
927 * Read Macros
928
929      SUBRM
930
931      IEI! I11,100
932      IEI! INM,C0
933      BECON! MM,127
934
935      GOSUB! GI
936      BEB! AA,ER,C0
937      IFNOT! AA,NDWH1
938      CHSON! CC
939      CASE! DE,CS1
940      GOSUB! GI
941      JR LOC77
942      CASE! RB,CS2
943      IEI! ILP,INM,I11
944      IEI! INM
945      BECON! ML,0
946      JR NDCH1
947      CASE! NL,CS2A
948      JR NDCH1
949
950      BECON! BB,'X'
951      BEB! AA,MF,BB
952      IFNOT! AA,IF1
953      BEB! UD,C0
954      JR IF2
955      BEB! UD,C1
956      IF2
957
958      BECON! OP,'P'
959      BECON! DE,'@'
960      BECON! OD,'V'
961      BECON! OS,'S'
962      BECON! OH,'H'
963      BECON! ON,'N'
964      BECON! OL,'L'
965      BECON! OC,'C'
966      BECON! OA,'+'
967      BECON! OR,'-'
968      BECON! OM,'*'
969      GOSUB! GI
970      BEB! OG,CC
971      BECON! AA,'X'
972      BEB! BB,AA,OG
973      IFNOT! BB,IF3
974      BECON! UG,0
975      JR IF4
976      BECON! UG,1
977      IF4
978
979      GOSUB! GI
980      BEB! AA,NL,CC
981      IFNOT! AA,IF5
982      MS! 'FLAG LINE'
983      STOP! 1
984      BECON! IUU,100
985      RET
986
987 * Read Macros
988
989      SUBRM
990
991      IEI! I11,100
992      IEI! INM,C0
993      BECON! MM,127
994
995      GOSUB! GI
996      BEB! AA,ER,C0
997      IFNOT! AA,NDWH1
998      CHSON! CC
999      CASE! DE,CS1
1000     GOSUB! GI
1001     JR LOC77
1002     CASE! RB,CS2
1003     IEI! ILP,INM,I11
1004     IEI! INM
1005     BECON! ML,0
1006     JR NDCH1
1007     CASE! NL,CS2A
1008     JR NDCH1
1009
1010     BECON! BB,'X'
1011     BEB! AA,MF,BB
1012     IFNOT! AA,IF1
1013     BEB! UD,C0
1014     JR IF2
1015     BEB! UD,C1
1016     IF2
1017
1018     BECON! OP,'P'
1019     BECON! DE,'@'
1020     BECON! OD,'V'
1021     BECON! OS,'S'
1022     BECON! OH,'H'
1023     BECON! ON,'N'
1024     BECON! OL,'L'
1025     BECON! OC,'C'
1026     BECON! OA,'+'
1027     BECON! OR,'-'
1028     BECON! OM,'*'
1029     GOSUB! GI
1030     BEB! OG,CC
1031     BECON! AA,'X'
1032     BEB! BB,AA,OG
1033     IFNOT! BB,IF3
1034     BECON! UG,0
1035     JR IF4
1036     BECON! UG,1
1037     IF4
1038
1039     GOSUB! GI
1040     BEB! AA,NL,CC
1041     IFNOT! AA,IF5
1042     MS! 'FLAG LINE'
1043     STOP! 1
1044     BECON! IUU,100
1045     RET
1046
1047 * Read Macros
1048
1049     SUBRM
1050
1051     IEI! I11,100
1052     IEI! INM,C0
1053     BECON! MM,127
1054
1055     GOSUB! GI
1056     BEB! AA,ER,C0
1057     IFNOT! AA,NDWH1
1058     CHSON! CC
1059     CASE! DE,CS1
1060     GOSUB! GI
1061     JR LOC77
1062     CASE! RB,CS2
1063     IEI! ILP,INM,I11
1064     IEI! INM
1065     BECON! ML,0
1066     JR NDCH1
1067     CASE! NL,CS2A
1068     JR NDCH1
1069
1070     BECON! BB,'X'
1071     BEB! AA,MF,BB
1072     IFNOT! AA,IF1
1073     BEB! UD,C0
1074     JR IF2
1075     BEB! UD,C1
1076     IF2
1077
1078     BECON! OP,'P'
1079     BECON! DE,'@'
1080     BECON! OD,'V'
1081     BECON! OS,'S'
1082     BECON! OH,'H'
1083     BECON! ON,'N'
1084     BECON! OL,'L'
1085     BECON! OC,'C'
1086     BECON! OA,'+'
1087     BECON! OR,'-'
1088     BECON! OM,'*'
1089     GOSUB! GI
1090     BEB! OG,CC
1091     BECON! AA,'X'
1092     BEB! BB,AA,OG
1093     IFNOT! BB,IF3
1094     BECON! UG,0
1095     JR IF4
1096     BECON! UG,1
1097     IF4
1098
1099     GOSUB! GI
1100     BEB! AA,NL,CC
1101     IFNOT! AA,IF5
1102     MS! 'FLAG LINE'
1103     STOP! 1
1104     BECON! IUU,100
1105     RET
1106
1107 * Read Macros
1108
1109     SUBRM
1110
1111     IEI! I11,100
1112     IEI! INM,C0
1113     BECON! MM,127
1114
1115     GOSUB! GI
1116     BEB! AA,ER,C0
1117     IFNOT! AA,NDWH1
1118     CHSON! CC
1119     CASE! DE,CS1
1120     GOSUB! GI
1121     JR LOC77
1122     CASE! RB,CS2
1123     IEI! ILP,INM,I11
1124     IEI! INM
1125     BECON! ML,0
1126     JR NDCH1
1127     CASE! NL,CS2A
1128     JR NDCH1
1129
1130     BECON! BB,'X'
1131     BEB! AA,MF,BB
1132     IFNOT! AA,IF1
1133     BEB! UD,C0
1134     JR IF2
1135     BEB! UD,C1
1136     IF2
1137
1138     BECON! OP,'P'
1139     BECON! DE,'@'
1140     BECON! OD,'V'
1141     BECON! OS,'S'
1142     BECON! OH,'H'
1143     BECON! ON,'N'
1144     BECON! OL,'L'
1145     BECON! OC,'C'
1146     BECON! OA,'+'
1147     BECON! OR,'-'
1148     BECON! OM,'*'
1149     GOSUB! GI
1150     BEB! OG,CC
1151     BECON! AA,'X'
1152     BEB! BB,AA,OG
1153     IFNOT! BB,IF3
1154     BECON! UG,0
1155     JR IF4
1156     BECON! UG,1
1157     IF4
1158
1159     GOSUB! GI
1160     BEB! AA,NL,CC
1161     IFNOT! AA,IF5
1162     MS! 'FLAG LINE'
1163     STOP! 1
1164     BECON! IUU,100
1165     RET
1166
1167 * Read Macros
1168
1169     SUBRM
1170
1171     IEI! I11,100
1172     IEI! INM,C0
1173     BECON! MM,127
1174
1175     GOSUB! GI
1176     BEB! AA,ER,C0
1177     IFNOT! AA,NDWH1
1178     CHSON! CC
1179     CASE! DE,CS1
1180     GOSUB! GI
1181     JR LOC77
1182     CASE! RB,CS2
1183     IEI! ILP,INM,I11
1184     IEI! INM
1185     BECON! ML,0
1186     JR NDCH1
1187     CASE! NL,CS2A
1188     JR NDCH1
1189
1190     BECON! BB,'X'
1191     BEB! AA,MF,BB
1192     IFNOT! AA,IF1
1193     BEB! UD,C0
1194     JR IF2
1195     BEB! UD,C1
1196     IF2
1197
1198     BECON! OP,'P'
1199     BECON! DE,'@'
1200     BECON! OD,'V'
1201     BECON! OS,'S'
1202     BECON! OH,'H'
1203     BECON! ON,'N'
1204     BECON! OL,'L'
1205     BECON! OC,'C'
1206     BECON! OA,'+'
1207     BECON! OR,'-'
1208     BECON! OM,'*'
1209     GOSUB! GI
1210     BEB! OG,CC
1211     BECON! AA,'X'
1212     BEB! BB,AA,OG
1213     IFNOT! BB,IF3
1214     BECON! UG,0
1215     JR IF4
1216     BECON! UG,1
1217     IF4
1218
1219     GOSUB! GI
1220     BEB! AA,NL,CC
1221     IFNOT! AA,IF5
1222     MS! 'FLAG LINE'
1223     STOP! 1
1224     BECON! IUU,100
1225     RET
1226
1227 * Read Macros
1228
1229     SUBRM
1230
1231     IEI! I11,100
1232     IEI! INM,C0
1233     BECON! MM,127
1234
1235     GOSUB! GI
1236     BEB! AA,ER,C0
1237     IFNOT! AA,NDWH1
1238     CHSON! CC
1239     CASE! DE,CS1
1240     GOSUB! GI
1241     JR LOC77
1242     CASE! RB,CS2
1243     IEI! ILP,INM,I11
1244     IEI! INM
1245     BECON! ML,0
1246     JR NDCH1
1247     CASE! NL,CS2A
1248     JR NDCH1
1249
1250     BECON! BB,'X'
1251     BEB! AA,MF,BB
1252     IFNOT! AA,IF1
1253     BEB! UD,C0
1254     JR IF2
1255     BEB! UD,C1
1256     IF2
1257
1258     BECON! OP,'P'
1259     BECON! DE,'@'
1260     BECON! OD,'V'
1261     BECON! OS,'S'
1262     BECON! OH,'H'
1263     BECON! ON,'N'
1264     BECON! OL,'L'
1265     BECON! OC,'C'
1266     BECON! OA,'+'
1267     BECON! OR,'-'
1268     BECON! OM,'*'
1269     GOSUB! GI
1270     BEB! OG,CC
1271     BECON! AA,'X'
1272     BEB! BB,AA,OG
1273     IFNOT! BB,IF3
1274     BECON! UG,0
1275     JR IF4
1276     BECON! UG,1
1277     IF4
1278
1279     GOSUB! GI
1280     BEB! AA,NL,CC
1281     IFNOT! AA,IF5
1282     MS! 'FLAG LINE'
1283     STOP! 1
1284     BECON! IUU,100
1285     RET
1286
1287 * Read Macros
1288
1289     SUBRM
1290
1291     IEI! I11,100
1292     IEI! INM,C0
1293     BECON! MM,127
1294
1295     GOSUB! GI
1296     BEB! AA,ER,C0
1297     IFNOT! AA,NDWH1
1298     CHSON! CC
1299     CASE! DE,CS1
1300     GOSUB! GI
1301     JR LOC77
1302     CASE! RB,CS2
1303     IEI! ILP,INM,I11
1304     IEI! INM
1305     BECON! ML,0
1306     JR NDCH1
1307     CASE! NL,CS2A
1308     JR NDCH1
1309
1310     BECON! BB,'X'
1311     BEB! AA,MF,BB
1312     IFNOT! AA,IF1
1313     BEB! UD,C0
1314     JR IF2
1315     BEB! UD,C1
1316     IF2
1317
1318     BECON! OP,'P'
1319     BECON! DE,'@'
1320     BECON! OD,'V'
1321     BECON! OS,'S'
1322     BECON! OH,'H'
1323     BECON! ON,'N'
1324     BECON! OL,'L'
1325     BECON! OC,'C'
1326     BECON! OA,'+'
1327     BECON! OR,'-'
1328     BECON! OM,'*'
1329     GOSUB! GI
1330     BEB! OG,CC
1331     BECON! AA,'X'
1332     BEB! BB,AA,OG
1333     IFNOT! BB,IF3
1334     BECON! UG,0
1335     JR IF4
1336     BECON! UG,1
1337     IF4
1338
1339     GOSUB! GI
1340     BEB! AA,NL,CC
1341     IFNOT! AA,IF5
1342     MS! 'FLAG LINE'
1343     STOP! 1
1344     BECON! IUU,100
1345     RET
1346
1347 * Read Macros
1348
1349     SUBRM
1350
1351     IEI! I11,100
1352     IEI! INM,C0
1353     BECON! MM,127
1354
1355     GOSUB! GI
1356     BEB! AA,ER,C0
1357     IFNOT! AA,NDWH1
1358     CHSON! CC
1359     CASE! DE,CS1
1360     GOSUB! GI
1361     JR LOC77
1362     CASE! RB,CS2
1363     IEI! ILP,INM,I11
1364     IEI! INM
1365     BECON! ML,0
1366     JR NDCH1
1367     CASE! NL,CS2A
1368     JR NDCH1
1369
1370     BECON! BB,'X'
1371     BEB! AA,MF,BB
1372     IFNOT! AA,IF1
1373     BEB! UD,C0
1374     JR IF2
1375     BEB! UD,C1
1376     IF2
1377
1378     BECON! OP,'P'
1379     BECON! DE,'@'
1380     BECON! OD,'V'
1381     BECON! OS,'S'
1382     BECON! OH,'H'
1383     BECON! ON,'N'
1384     BECON! OL,'L'
1385     BECON! OC,'C'
1386     BECON! OA,'+'
1387     BECON! OR,'-'
1388     BECON! OM,'*'
1389     GOSUB! GI
1390     BEB! OG,CC
1391     BECON! AA,'X'
1392     BEB! BB,AA,OG
1393     IFNOT! BB,IF3
1394     BECON! UG,0
1395     JR IF4
1396     BECON! UG,1
1397     IF4
1398
1399     GOSUB! GI
1400     BEB! AA,NL,CC
1401     IFNOT! AA,IF5
1402     MS! 'FLAG LINE'
1403     STOP! 1
1404     BECON! IUU,100
1405     RET
1406
1407 * Read Macros
1408
1409     SUBRM
1410
1411     IEI! I11,100
1412     IEI! INM,C0
1413     BECON! MM,127
1414
1415     GOSUB! GI
1416     BEB! AA,ER,C0
1417     IFNOT! AA,NDWH1
1418     CHSON! CC
1419     CASE! DE,CS1
1420     GOSUB! GI
1421     JR LOC77
1422     CASE! RB,CS2
1423     IEI! ILP,INM,I11
1424     IEI! INM
1425     BECON! ML,0
1426     JR NDCH1
1427     CASE! NL,CS2A
1428     JR NDCH1
1429
1430     BECON! BB,'X'
1431     BEB! AA,MF,BB
1432     IFNOT! AA,IF1
1433     BEB! UD,C0
1434     JR IF2
1435     BEB! UD,C1
1436     IF2
1437
1438     BECON! OP,'P'
1439     BECON! DE,'@'
1440     BECON! OD,'V'
144
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346 CS2A CASE! LF,CS2B ;IGNORE LF
347 JP NDCH1
348 CS2B CASE! RC,CS3 ;IGNORE COMMENTS
349 BIEB! LS,III,RC ;LS(III)=RC
350 IINC! III
351 BSLB! AA,ML,MM ;AA=ML<MM
352 IFNOT! AA,IF6
353 BEB! MM,ML
354 IF6 GOSUB! G1
355 WH2 BNEB! AA,CC,LF ;AA=CC=LF
356 IFNOT! AA,NDWH2
357 JR WH2
358 NDWH2
359 CS3 CASE! DG,CS4
360 IFNOT! UG,IF7
361 IF8 JR LOC77
362 IF7 JP LOC77
363 IF8 JP NDCH1
364 REM
365 CS4 BIEB! LS,III,CC ;LS(III)=CC
366 LOC77 IINC! III
367 ISLI! AA,ILM,III ;AA=ILM<III
368 IFNOT! AA,IF9
369 MS! 'MACMEMXST'
370 GOSUB! CR
371 CLOSE! F1
372 STOP! 5
373 IF9 BINC! ML
374 NDCH1 JP WH1
375 NDWH1 BNEB! AA,CC,EF ;AA=CC=EF
376 IF10 IFNOT! AA,IF10
377 MS! 'DEFN READ'
378 STOP! 2
379 CLOSE! F1
380 IECON! IRC,3
381 * ASSOCIATE PCB 3 WITH IBC
382 BECON! TR,'R'
383 OPEN! F1,TR,IBC
384 IEI! IED,III ;IED=III ;END OF DEFS
385 MS! 'LOADED...'
386 IEI! ITU,III
387 GOSUB! PN
388 MS! 'BYTES FO'
389 MS! 'R DEFINES'
390 GOSUB! CR
391 IEI! ILP,INM,III ;ILP(INM)=III
392 IEI! ITU,INM
393 MS! 'MACROS...'
394 IEI! ITU,MM ;ITU=MM
395 GOSUB! PN
396 MS! 'MIN LEN.'
397 GOSUB! CR
398 RET
399 * Do carriage return
400 *
401 SUBCR WRITE! NL

```

```

481 BEB! AA,CC
482 GOSUB! CD
483 IEI! ITU,AA
484 JP NDCH2
485 CS10 CASE! DT,CS11 ;TURN ON TRACE MODE
486 BECON! UT,1 ;UT=+001
487 JR NDCH2
488 REM
489 IEI! ITU,IUU
490 IINC! IUU
491 IFNOT! UT,IF17
492 IEI! III,ITU
493 GOSUB! PN
494 IEI! ITU,ISS,SP ;ITU=ISS(SP)
495 GOSUB! PN
496 IEI! ITU,SP ;ITU=SP
497 GOSUB! PN
498 IEI! ITU,III
499 GOSUB! CR
500 IF17 CHSON! D3 ;CHOOSE ON D3
501 CASE! OC,CS12 ;CHAR OUTPUT
502 BEI! AA,ITU
503 GOSUB! WA
504 JP NDCH3
505 CASE! OS,CS13 ;PUT ON STACK
506 BINC! SP
507 BLEB! AA,C4,SP
508 IFNOT! AA,IF18
509 MS! 'S OVERFLOW'
510 GOSUB! CR
511 BEB! SP,C4
512 ISS,SP,ITU
513 NDCH3
514 JP
515 CASE! OP,CS14 PUT INTO PARAMETER LOCATION
516 IEI! IPR,DG,ITU
517 NDCH3
518 CASE! OA,CS15 ;ADD TO STACK
519 IF18! IAA,ISS,SP
520 IEI! IAA,IAA,ITU ;IAA=IAA+ITU
521 IEI! ISS,SP,IAA
522 NDCH3
523 CASE! OR,CS16 ;SUBTRACT FROM STACK
524 IEI! IAA,ISS,SP
525 IEI! IAA,IAA,ITU ;IAA=IAA-ITU
526 IEI! ISS,SP,IAA
527 NDCH3
528 CASE! OM,CS17 ;MULTIPLY BY BASE AND ADD
529 IEI! IAA,ISS,SP
530 IEI! IAA,IAA,ITU ;IAA=IAA*ITU
531 IEI! ISS,SP,IAA
532 IEI! IAA,IAA,ITU
533 IEI! IAA,IAA,ITU
534 IEI! ISS,SP,IAA
535 NDCH3
536 CASE! OH,CS18 ;OUTPUT HIGH BYTE
537 IEI! ITU,AA,BB ;UNPACK(ITU,AA,BB)
538 GOSUB! WA
539 JR NDCH3
540 GOSUB! WN
541 IF14 ELSE END OF ACTION SECTION
542 REM
543 BEI! AA,LS,IMP
544 IFNOT! UN,IF19
545 BNEB! BB,AA,RC ;BB=AA=RC
546

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(Continued on top of page 32)

(Continued on next page)

Tinsource (Listing continued, text begins on page 25)

Listing Two (Continued)

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547 JR IF20
548 IF19 BB,C1
549 IF20 IFNOT! BB,IF21
550 GOSUB! WA
551 JR IF21
552 IF21 BB! AA,NL
553 GOSUB! WA
554 BB! AA,LF
555 GOSUB! WA
556 IF22
557 IF14
558 -
559 IINC! IMP
560 NDWH3 JP WH3
561 BECON! UT,0
562 RET
563 *
564 * Write a byte to output
565 *
566 SUBWA WRFIL! AA,F2
567 RET
568 *
569 * Get a char from input file
570 *
571 SUBGI RDFIL! CC,F1
572 RET
573 *
574 * Get char & goto LOC88 on end
575 *
576 SUBGC GOSUB! GI
577 BNEB! AA,ER,C0
578 IFNOT! AA,IF22A
579 GOTO! 88
580 IF22A BEEB! AA,CC,EF
581 IFNOT! AA,IF23
582 GOTO! 88
583 IF23
584 RET
585 *
586 * Converts number to series of ascii digit
587 *
588 SUBSD ISLI! AA,ITU,I00
589 IFNOT! AA,IF24
590 BECON! BB,1
591 IEMI! ITU,ITU
592 JR IF25
593 IF24 BECON! BB,0
594 IF25
595 ICEI! AA,ITU,I00
596 IFNOT! AA,IF26
597 BEB! ND,C1
598 BEEB! DS,C0,ZR
599 JP IF27
600 IF26 BEB! ND,C0
601 WH4 ISLI! AA,I00,ITU
602 IFNOT! AA,NDWH4
603 IDV! IYV,ITU,I10
604 ITMS! IAA,I10,IYV
605 IEMI! IXX,ITU,IAA
606 IEI! ITU,IYV
607 BEI! AA,IXX
608 BEEB! AA,AA,ZR
609 BEEB! DS,ND,AA
610 BINC! ND
611 JR WH4
612 NDWH4
613 IF27
614
615 BEEB! DS,ND,OR
616 BEEB! ND,ND,BB
617 RET
618 * Write # into F2
619 *
620 SUBWN GOSUB! SD
621 WHS IEI! IAA,ND
622 ISLI! AA,I00,IAA
623 IFNOT! AA,NDWH5
624 BDEC! ND
625 BEEB! AA,DS,ND
626 GOSUB! WA
627 JR WHS
628 NDWH5
629 RET
630 *
631 * Write # to terminal
632 *
633 SUBPN GOSUB! SD
634 WH6 IEI! IAA,ND
635 ISLI! AA,I00,IAA
636 IFNOT! AA,NDWH6
637 BDEC! ND
638 BEEB! AA,DS,ND
639 WRITE! AA
640 JR WH6
641 NDWH6
642 WRITE! BL
643 RET
644 *
645 * Convert AA as a decimal digit
646 *
647 SUBCD BLEB! BB,ZR,AA
648 BLEB! CC,AA,C9
649 BEEB! BB,BB,CC
650 IFNOT! BB,IF28
651 BEBMB! AA,AA,ZR
652 RET
653 IF28 BEB! AA,C0
654 RET
655 *
656 * Convert AA as hex digit
657 *
658 SUBCH BLEB! BB,ZR,AA
659 BLEB! CC,AA,C9
660 BEEB! BB,BB,CC
661 IFNOT! BB,IF29
662 BEBMB! AA,AA,ZR
663 RET
664 IF29 BLEB! BB,HA,AA
665 BLEB! CC,AA,HF
666 BEEB! BB,BB,CC
667 IFNOT! BB,IF30
668 BEBMB! AA,AA,HA
669 BEEB! AA,AA,CX
670 RET
671 IF30 BEB! AA,C0
672 RET
673 *
674 (A:TINCMP) ff

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(Continued on column 2)

End Listing

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Simplified 68000 Mnemonics

If the 68000 is to become the most important new computer of the next five years, there will necessarily be a tremendous amount of interest in its assembly language. The profusion of features and facilities on the 68000, however, makes it very difficult to get a clear overall view of the instruction set. If one is to program reasonably well in assembly language, one must be able to lay out in one's mind which facilities are there and which are not. With the 68000, it often seems as if one is let loose upon a tropical island, full of flowers of dazzling beauty but so much underbrush that it seems impossible to scale its central mountain peak and survey the totality of the landscape.

The main problem is with the mnemonics. This is not to say that the mnemonics show any glaring examples of bad design. They are serviceable, as far as they go; it is simply that it is possible to do much better. The purpose of this paper is to *propose* a new collection of mnemonics for the 68000. This is not to say that an assembler has been written, using these mnemonics (at the moment the author does not have access to a 68000-based system). Rather, the purpose here is to show the many advantages of this set of mnemonics over Motorola's. There is precedent for such redesigns; for example, the mnemonics of the UNIVAC 1100 series were redone by CSC in 1962 in connection with CSC's design of the EXEC II operating system for the 1100 series (a project in which this author took part).

The new mnemonics are given in Table I. The notation used in Table I is explained in Table II. It is important to note that the new mnemonics allow the entire instruction repertoire of the 68000 — together with very brief explanations of all instructions — to be presented upon one single-spaced page, with all notational conventions laid out on another single-spaced page.

A program selected at random from a recent book on the 68000¹ is presented in Table III with both the old and new mnemonics. Except for labels, which remain the same in the two cases, the total number of keystrokes of non-blank char-

acters has been reduced from 196 to 98 — a reduction of 50%. The simplicity of understanding for the new mnemonics makes it easy, in fact, to spot a bug in the program of Table III. This will be explained in more detail at the end of the paper.

The basic ideas behind the new mnemonics are as follows:

(1) *The data registers and the address registers all receive new designations.* The data registers are now called the A, B, C, D, E, F, G, and H registers, each of which is 32 bits long. The address registers are

now called the S, T, U, V, W, X, Y, and Z registers, and each of these is 32 bits long. In particular, the S register is the stack pointer, known conventionally as A7. (The original designations for the registers A through H are D0 through D7, and those for S through Z are A7 through A0, in reverse order, with A0 corresponding to Z.)

(2) *There are no suffixes B, W, and L for byte, word, and long word operations.* As we shall see, most instructions do not need such suffixes because they operate on data which has been defined as byte,

G OPERATION	DESCRIPTION	G OPERATION	DESCRIPTION
3 A <u>v</u> , <u>i</u>	Add <u>i</u> to <u>v</u>	3 N <u>v</u> , <u>i</u>	Logical AND <u>i</u> to <u>v</u>
1 Aa <u>v</u>	Add <u>v</u> to <u>a</u> (<u>v</u> ≠ 1t)	6 Na <u>v</u>	Logical AND <u>v</u> to <u>a</u>
ABab	Add BCD 1b to 1a	NBa	Negate BCD 1a
ABtu	Add BCD 1MDu to 1MDt	4 NBM <u>vl</u>	Negate BCD <u>vl</u> in mem.
4 AMa <u>v</u>	Add <u>a</u> to <u>v</u> (memory)	NCC <u>il</u>	Logical AND <u>il</u> to CC
4 ASd <u>v2</u>	Arith. shift <u>v2</u> by 1	NGma	Negate <u>ma</u> (2's comp.)
ASd <u>ma</u> , <u>sc</u>	Arith. shift <u>ma</u> by <u>sc</u>	4 NGM <u>v</u>	Negate <u>v</u> in memory
1 At <u>vx</u>	Add <u>vx</u> to <u>t</u>	3 NMa <u>v</u>	AND <u>a</u> to <u>v</u> (memory)
AXmab	Add extended <u>mb</u> to <u>ma</u>	NO	No operation
AXmtu	" " <u>mMDu</u> to <u>mMDt</u>	P NSR <u>i2</u>	Logical AND <u>i2</u> to SR
2 An <u>v</u>	Add <u>n</u> to <u>v</u> (<u>v</u> ≠ 1t)	NTma	NOT <u>ma</u> (ones' compl.)
B <u>p</u>	Branch to <u>p</u>	4 NTM <u>v</u>	NOT <u>v</u> in memory
Baf <u>i2</u>	Test bit <u>i2</u> of <u>a</u> , op <u>f</u>	NXma	Negate extended <u>ma</u>
Bafb	" " <u>y</u> (in <u>b</u>) " " " "	4 NXM <u>v</u>	" " <u>v</u> in memory
BaT <u>i2</u>	Test bit <u>i2</u> of <u>a</u>	3 O <u>v</u> , <u>i</u>	Logical OR <u>i</u> to <u>v</u>
BaTb	Test bit <u>y</u> (in <u>b</u>) of <u>a</u>	6 Oa <u>v</u>	Logical OR <u>v</u> to <u>a</u>
Bcc <u>p</u>	Branch to <u>p</u> on <u>cc</u>	OCC <u>il</u>	Logical OR <u>il</u> to CC
4 Bf <u>vl</u> , <u>i2</u>	Test bit <u>i2</u> of <u>vl</u> , op <u>f</u>	3 OMa <u>v</u>	OR <u>a</u> to <u>v</u> (memory)
4 Bfa <u>vl</u>	" " <u>y</u> (in <u>a</u>) " " " "	P OSR <u>i2</u>	Logical OR <u>i2</u> to SS
BS <u>p</u>	Branch to subroutine <u>p</u>	7 PA <u>v</u>	Push address of <u>v</u>
5 BT <u>vl</u> , <u>i2</u>	Test bit <u>i2</u> of <u>vl</u>	1 PH <u>v</u>	Push <u>v</u> (= M <u>mMDS</u> , <u>v</u>)
BTa <u>vl</u>	Test bit <u>y</u> (in <u>a</u>) of <u>vl</u>	1 PL <u>v</u>	Pull <u>v</u> (= M <u>v</u> , <u>mMSI</u>)
3 C <u>v</u> , <u>i</u>	Compare <u>i</u> with <u>v</u>	PMxa Q(<u>t</u>)	<u>xa</u> +Q(<u>t</u>) alternate bytes
1 Ca <u>v</u>	Compare <u>a</u> with <u>v</u> (<u>v</u> ≠ 1t)	Pxa Q(<u>t</u>)	Q(<u>t</u>)+ <u>xa</u> " " (periph.)
6 Cka <u>v2</u>	Check <u>2a</u> bounded by <u>v2</u>	R	Return from subroutine
Cmtu	Compare <u>mMtl</u> with <u>mMuI</u>	RE	" " exceptn. (pull SR)
1 Ct <u>vx</u>	Compare <u>t</u> with <u>vx</u>	8 RM <u>rs</u> , <u>vx</u>	Regs to memory <u>rs</u> → <u>vx</u>
Dcca <u>p</u>	Bcc <u>β</u> ; <u>a</u> -1; <u>a</u> =-1? → <u>p</u> ; <u>β</u> :	RMxt <u>rs</u>	Regs-mem. (=RM <u>rs</u> , <u>xMDt</u>)
6 Dsa <u>v2</u>	Divide signed <u>4a/v2</u>	ROd <u>v2</u>	Rotate <u>v2</u> by 1
6 Dua <u>v2</u>	Divide unsigned <u>4a/v2</u>	ROd <u>ma</u> , <u>sc</u>	Rotate <u>ma</u> by <u>sc</u>
Ea	Exchange halves of <u>a</u>	RR	Ret.&restore (pull CC)
Egh	Exchange <u>4g</u> with <u>4h</u>	RS	Reset external devices
FAt <u>-i2</u>	Frame allocation (<u>iMt</u>)	RXd <u>v2</u>	Rot. extended <u>v2</u> by 1
FDt	Frame deallocation	RXd <u>ma</u> , <u>sc</u>	Rot. extended <u>ma</u> by <u>sc</u>
H <u>i2</u>	Halt (status reg. + <u>i2</u>)	3 S <u>v</u> , <u>i</u>	Subtract <u>i</u> from <u>v</u>
7 J <u>v</u>	Jump to <u>v</u>	1 Sa <u>v</u>	Subtr. <u>v</u> from <u>a</u> (<u>v</u> ≠ 1t)
7 JS <u>v</u>	Jump to subroutine <u>v</u>	SBab	Subtr. BCD 1b from 1a
7 LA <u>t</u> , <u>v</u>	Load <u>t</u> with addr. of <u>v</u>	SBtu	" " 1MDu from 1MDt
4 Lsd <u>v2</u>	Logical shift <u>v2</u> by 1	3 Scc <u>vl</u>	Set <u>vl</u> =-1 (if <u>cc</u>) or 0
Lsd <u>ma</u> , <u>sc</u>	Logical shift <u>ma</u> by <u>sc</u>	4 SMA <u>v</u>	Subtr. <u>a</u> from <u>v</u> (mem.)
1 M <u>v</u> , <u>w</u>	Move <u>w</u> to <u>v</u> (<u>w</u> ≠ 1t)	1 St <u>vx</u>	Subtract <u>vx</u> from <u>t</u>
1 Ma <u>v</u>	Move <u>v</u> to <u>a</u> (<u>v</u> ≠ 1t)	SXmab	Subtr. extended <u>ma</u> - <u>mb</u>
6 MCC <u>v2</u>	Move <u>v2</u> (byte 2) to CC	SXmtu	Subtr. ext. <u>mMDt</u> - <u>mMDu</u>
MKa <u>k</u>	Move signed const. <u>k</u> → <u>a</u>	2 Sn <u>v</u>	Subtr. <u>n</u> from <u>v</u> (<u>v</u> ≠ 1t)
1 MMa <u>v</u>	Move <u>a</u> to <u>v</u> (memory)	3 TE <u>v</u>	Test <u>v</u> , set flags N&Z
1 MMt <u>vx</u>	Move <u>t</u> to <u>vx</u> (memory)	TR <u>vn</u>	Trap, using vector <u>vn</u>
9 MR <u>rs</u> , <u>vx</u>	Move <u>vx</u> → registers <u>rs</u>	3 TS <u>vl</u>	TE <u>vl</u> ; <u>vl</u> (hi-order)=1
MRxt <u>rs</u>	Move regs(=MR <u>rs</u> , <u>xMtI</u>)	TV	BVC <u>β</u> ; TR 7; <u>β</u> :
6 Msa <u>v2</u>	Multiply signed <u>2a*v2</u>	3 X <u>v</u> , <u>i</u>	Exclusive OR <u>i</u> to <u>v</u>
3 MSM <u>v2</u>	Move status reg. to <u>v2</u>	XCC <u>il</u>	Exclusive OR <u>il</u> to CC
P MSR <u>v2</u>	Move <u>v2</u> to status reg.	3 XMa <u>v</u>	Excl. OR <u>a</u> to <u>v</u> (mem.)
P MSt	Move <u>t</u> to S	P XSR <u>i2</u>	Exclusive OR <u>i2</u> to SR
1 Mt <u>vx</u>	Move <u>vx</u> to <u>t</u>	Xxa	Extend sign <u>a</u> (to <u>xa</u>)
P Mts	Move <u>s</u> to <u>t</u>	3 Z <u>v</u>	Zero (clear) <u>v</u>
6 MUa <u>v2</u>	Multiply uns. <u>2a*v2</u>		

Table I

by W.D. Maurer

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word, or long word data, which determines the type of the operation automatically. In cases where the length must be given, however, it is given in bytes as 1, 2, or 4. This has the immediate advantage of avoiding the non-standard term "word." (A word has 32 bits, not 16, on the IBM 360 and 370, for example.)

The length designation appears in the following places:

- (a) *In certain of the mnemonics.* The instruction whose Motorola mnemonic is ADDX.L D4,D3 (Add Extended, Long Word, register D4 to register

D3) is simply AX4DE in the new mnemonics. Here D and E denote the D register (formerly D3) and the E register (formerly D4) and the 4 denotes, very simply, "four bytes." Note that the order is "destination first, then source"; see point (3) below to appreciate how much simpler this makes a great number of the mnemonics. The corresponding byte and word comparison instructions ADDX.B D4,D3 and ADDX.W D4,D3 become AX1DE and AX2DE respectively.

- (b) *Preceding register designations.* The instruction MOVE.L A3,A6 (old mnemonics) moves A3 to A6. Renaming these registers W and T respectively, we can write M 4T,4W (reversing the order as before). It is simpler, however, to write MT 4W where MT means "move to the T register" and 4W means "four bytes of the W register." The corresponding byte and word move instructions MOVE.B A3,A6 and MOVE.W A3,A6 become MT 1W and MT 2W respectively.

- (c) *As part of more general addressing modes.* Address register indirect addressing, involving the X register, in a one-byte instruction, would be denoted by 1MX (*one byte of memory indexed by X*.) The same thing, with auto-increment or auto-decrement, would be 1MXI or 1MDX respectively. (Note that the I, for "increment," follows the register name, whereas D, for "decrement," precedes it; this resembles the placement of + and - in the Motorola mnemonics, and is done for the same reason - because incrementation follows the reference to memory, while decrementation precedes it.) Even the most complex mode, namely based indexed long, is straightforward; thus 2MU4E-9 means "two bytes of memory, indexed by the U register and by all four bytes of the E register, minus the displacement 9." The same thing in Motorola mnemonics would be -9(A5,D4.L) - over 50% more characters (not counting the extra .W on the instruction mnemonic) and lacking the straightforward readability of the new expression.

- (3) *Most operation codes have only one argument.* In fact the only operation codes with two arguments are moves, shifts, and immediate addressing instructions. Thus M KPREV,KCURR sets KPREV (in memory) equal to KCURR (in memory); A FCOUNT,5 adds 5 to FCOUNT in memory; ASL 1H,4 shifts 1H (*one byte of the H register, formerly known as D7*) left arithmetically by 4. (If the mnemonic variations are counted separately - if MA through MH are counted as eight instructions instead of one, for example - then almost 75% of the mnemonics have no arguments; about 25% have one; and only 2% have two.)

a = A, B, C, D, E, F, G, or H (data registers)
b = A, B, C, D, E, F, G, or H (data registers)
CC = condition code register (rightmost byte of SR)
cc = one of the following forms:

T true	VC overflow clear
F false	VS overflow set
HI high	PL plus
LS low or same	MI minus
CC carry clear	GE greater or equal
CS carry set	LT less than
NE not equal	GT greater than
EQ equal	LE less or equal

d = L (left shift) or R (right shift)
e = label, label+j, or other address expression (length defined in definition of given label) or mBlabel (length m)
f = N (op=AND with 0), O (op=OR with 1), or X (op=XOR with 1)
g = A, B, C, D, E, F, G, H, S (stack pointer), T, U, V, W, X, Y, or Z (data register or address register); length = 4
h -- same as g (second register in exchange instruction)
i = y (constant) or e (address of e) (immediate data)
i1 -- same as i but length must be 1 (immediate data)
i2 -- same as i but length must be 2 (immediate data)
l = \$hh... or dd... or %bb... where the h's are hexadecimal digits, the d's decimal digits, and the b's binary digits (constant)
k -- +k is +0 through +127; -k is -1 through -128 (constant in move instruction MK; 8-bit displacement in based indexed modes)
m -- 1, 2, or 4 (length, or number of bytes in register or memory)
n -- 1, 2, 3, 4, 5, 6, 7, or 8 (additive or subtractive constant)
p = q3, but *-32766 ≤ p ≤ +32769 (relative address; *this loc.)
q = e (data) or mBj (data, length m, at address j) (memory loc.)
q2 -- same as q but address must have length 2 (memory location)
q3 -- same as q but address must have length 3 (memory location)
r = q3, but *-126 ≤ r ≤ +129 (relative address; *this location)
rs = z1/z2/... where each zk = g or g-h (g, h as above; g-h means registers g, g+1, ..., h) (multiple registers for MR and RM)
sc = 1, 2, 3, 4, 5, 6, 7, 8, A, B, C, D, E, F, G, H (shift count)
-- in rightmost 6 bits of register A-H if this is specified
SR = status register (length 2; CC = rightmost byte of SR)
t = S (stack pointer), T, U, V, W, X, Y, or Z (address registers)
u = S (stack pointer), T, U, V, W, X, Y, or Z (address registers)
v = one of the following forms (variable in register or memory):

#i (immediate)	(Groups 1 and 6 only)
q3 (absolute long)	(All groups)
q2 (absolute short)	(All groups)
ma (data register direct)	(Groups 1, 2, 3, and 6 only)
mt (address register direct)	(Groups 1 and 2 only)
mMt (address register indirect)	(All groups)
mMl (post-increment)	(All groups except 7 and 8)
mMd (pre-decrement)	(All groups except 7 and 9)
mMtg or mMtg+k (based indexed short)	(all groups)
mMt4g or mMt4g+k (based indexed long)	(all groups)
q2(t) or mMt+q2 (based)	(All groups)
p (relative)	(Groups 1 and 5 through 9 only)
r(t) or r(4t) (relative indexed)	(Groups 1 and 5 through 9 only)

vm -- like v but with length m (variable in register or memory)
vn -- 0 through 15 (vector number in trap instruction)
w -- like v in M v,w but group 3 and length must equal length of v
x -- like m, but x ≠ 1 (vx is like v but with length 2 or 4)
y = mBj (length m) or j (length as small as possible) (integer)

Table II

The destination register in a great number of the arguments is incorporated into the mnemonic. For the C register, for example (formerly D2), we have MC (move to C, AC, SC, CC (add, subtract, and compare), MSC, MUC, DSC, DUC (multiply and divide by C, signed and unsigned), NC (AND), OC (OR), and so on. For a few "operate to memory instructions" such as AMC (add to memory), SMC, NMC, and OMC, the C register is the source, rather than the destination. There are also EC (exchange halves of C), ECD (exchange C and D), NG4C (set C to its two's complement), X2C and X4C (extend sign to two bytes or four bytes of C), and other such exceptional cases.

(4) All operations on data have lengths determined by the data unless otherwise directed. If AMOUNT is a 32-bit variable, then MF AMOUNT moves AMOUNT to the F register, and is a long-word (32-bit) operation. To move only one or two bytes of AMOUNT to the F register, one uses MF 1BAMOUNT or MF 2BAMOUNT respectively.

Tables I and II are meant to be used in tandem. As an example, consider the second entry in Table I, namely $Aa\ v$ (Add v to a). By consulting Table II, one learns that a may be A, B, C, D, E, F, G, or H, and that v may have one of several forms. Let us consider the form mt .

Here m is 1, 2, or 4, but in the description of $Aa\ v$ we find the designation " $v \neq 1t$ "; that is, v cannot be of the form $1t$, so that m , here, must be 2 or 4, while t is S, T, U, V, W, X, Y, or Z (again by reference to Table II). Thus there are the following possibilities (for example):

AA 2X
(Add to A from two bytes of X)
AD 4T
(Add to D from four bytes of T)

for a total of 128 ($8 \times 2 \times 8$) possibilities. Another form of v , in this same instruction, is $q3$, described as "same as q but address must have length 3." So this is a 24-bit (or three-byte) address, and we have the following further possibilities for v :

$q = e = \text{label}$
(label of location with three-byte address)
 $q = mBj = 4B\$hh...$
(length 4, but address still has length 3)
 $q = e = \text{label} \pm j = \text{label} + dd...$
 $q = e = mB\text{label}$
(data has length m ; address has length 3)

This means that if NST is a two-byte variable, ECOUNT a four-byte variable, and

F7 an array of single-byte variables, we could also write

AF ECOUNT
(Add to four bytes of F from ECOUNT)
AD 4B\$FC
(Add to D from four bytes starting at address \$FC)
AG F7+50
(Add to one byte of G from byte 50 of F7)
AA 1BNST
(Add to one byte of A from one byte of NST)

Still another form of v , in this same instruction, is $\#i$, for immediate data. By Table II, we can have $i = y = mBj = 4B\$hh...$ which gives us the possible instruction

AD #4B\$FC
(Add \$FC to four bytes of D)

Note the two meanings of the 4 in 4B\$FC — in this instruction it means "the constant \$FC as a four-byte constant," whereas in AD 4B\$FC it means "four bytes of memory."

The column headed G in Table I is the group. Instructions belong to groups, and each group can use only certain of the v options as specified in Table II. For example, the instruction $LA\ t\ v$ belongs to group 7. This means that v can be of

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<u>OLD MNEMONICS</u>												<u>NEW MNEMONICS</u>											
PGM_9_4A	MOVEA.L	LIST,A0										PGM_9_4A	MZ	LIST									
	CLR.W	D0											Z	2A									
	MOVE.B	(A0)+,D0											MA	1MZI									
	LEA	-1(A0,D0.W),A1											LAY	1MZA-1									
SORT	CLR.W	D1										SORT	Z	2B									
	MOVEA.L	A0,A2											MX	4Z									
NEXT	MOVE.B	(A2)+,D0										NEXT	MA	1MXI									
	CMP.B	(A2),D0											CA	1MX									
	BCC.S	NSWITCH											BCC	NSWITCH									
	MOVE.B	(A2),D1											MB	1MX									
NSWITCH	MOVE.B	D1,-1(A2)											MMB	1MX-1									
	MOVE.B	D0,(A2)											MMA	1MX									
	ADDQ.W	#1,D1											A1	2B									
	CMPL.L	A2,A1										NSWITCH	CY	4X									
	BHI	NEXT											BHI	NEXT									
	TST.W	D1											TE	2B									
	BNE	SORT											BNE	SORT									
		RTS												R									
<u>REGISTERS</u>																							
<u>OLD</u>	D0	D1	D2	D3	D4	D5	D6	D7	A0	A1	A2	A3	A4	A5	A6	A7							
<u>NEW</u>	A	B	C	D	E	F	G	H	Z	Y	X	W	V	U	T	S							

Table III

the form $r(t)$ or $r(4t)$, since these are specified in Table II as "groups 1 and 5 through 9 only." Thus if WTABLE is a suitable relative address, then each of the following is *legal*:

LAT WTABLE(Z)

(Load address of WTABLE plus Z into T)

LAV WTABLE(4W)

(Load address of WTABLE plus W into V)

where two bytes of Z, and four bytes of W, are used. On the other hand, v cannot be of the form $mMtI$ or $mMDt$, since these are specified in Table II as "all groups except 7 and 8" or "all groups except 7 and 9." Thus each of the following is *illegal*:

LAT 2MZI

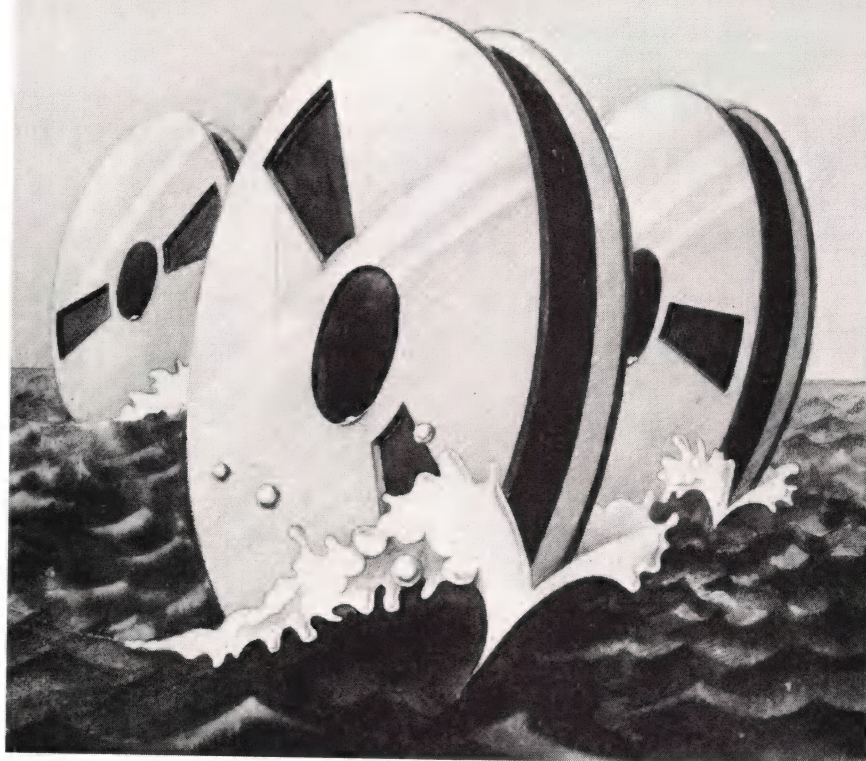
LAV 4MDW

It should be noted that the length (1, 2, or 4) is meaningless in the case of the specific instructions LA_t , PA_t , J, and JS. Thus in the program of Table III, LAY 1MZA-1 means "Load Address, into Y, of the memory word indexed by Z and by A, minus 1." The 1 before the M means nothing, but it must be present (although 2 or 4 would do just as well), since LAY MZA-1 would load the address of a variable called MZA, minus 1. (Privileged instructions are group P.)

Examples of the v options which start with a length (1, 2, or 4) are as follows:

- (1) 1C (one byte of the C register; the other three bytes are ignored)
- (2) 2V (two bytes of the V register; extended through the other two bytes)
- (3) 1MU (one byte in memory, indexed by U — that is, the address of this byte is contained in U)
- (4) 2MWI (two bytes in memory, indexed by W, and then increment W by 2 after making the reference)
- (5) 4MDT (four bytes in memory, indexed by T, and decrement T by 4 before making the reference)
- (6) 2MUE (two bytes in memory, indexed by U and by E — that is, the address of this byte is the sum of U and two bytes of E)
- (7) 1MWX (one byte in memory, indexed by W and by X)
- (8) 4MZ4G (four bytes in memory, indexed by Z and all four bytes of G)
- (9) 4MX+8 (four bytes in memory,

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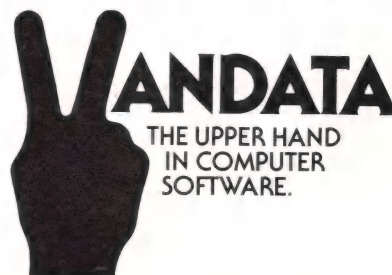
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A=M(HL)	MOV A,M
A=M(DE)	LDAX D
M(DE)=A	STAX D
HL=M(L6)	LHLD L6
HL=5	LXI H,5

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indexed by X and by Y, plus 8 — that is, the address of this byte is the sum of X and two bytes of Y, plus 8)

- (10) 1MZ4S-16 (one byte in memory, indexed by Z and by all four bytes of the stack pointer S, minus 16)

Table IV gives examples of all the instructions in both the old and the new mnemonics; Table V gives a more expanded explanation of the program of Table III. We may note from Table V that the use of the new mnemonics makes it much

easier to spot a bug in this sorting program, intended to sort a table of unsigned, single-byte quantities into descending order. The B register (formerly D1) is being used as the exchange flag: set to zero (Z 2B), incremented to show the exchange (A1 2B), and tested at the end TE 2B). But it is also used as a temporary register in moving 1MX to 1MX-1 (in the instructions MB 1MX and MMB 1MX-1). If the bug is not fixed, the instruction A1 2B might increment -1 to zero, making it look like the exchange flag is still clear.

MNEMONIC	EXAMPLE	MOTOROLA MNEMONIC	MNEMONIC	EXAMPLE	MOTOROLA MNEMONIC
A v, i	A 2MZ1,1	ADD.W #1,(A0)+	N v, i	N 4MDY,8	AND.L #8,-(A1)
Aa v	AA 4MDY	ADD.L -(A1),D0	Na v	NB 1MX1	AND.B (A2)+,D1
ABab	ABGH	ABCD D7,D6	NBa	NBC	NBCD D2
ABtu	ABWX	ABCD -(A2),-(A3)	NBM v1	NBM 1MZT	NBCD 0(A0,A6)
AMa v	AMB BYT1	ADD.B D1,BYT1	NCC i1	NCC \$1A	AND.B # \$1A,SR
ASd v2	ASR WD1	ASR WD1	NGma	NG1A	NEG.B D0
ASd ma, sc	ASL 2C,4	ASL.W 4,D2	NGM v	NGM 2MUD	NEG.W 0(A5,D3)
At vx	AY 4MV	ADD.L (A4),A1	NMa v	NMD 4MDS	AND.L D3,-(A7)
AXmab	AX1DE	ADDX.B D4,D3	NO	NO	NOP
AXmtu	AX2UZ ADDX.W -(A0),-(A5)		NSR i2	NSR \$FOF	AND.W # \$FOF,SR
An v	A4 4F	ADDQ.L #4,D5	NTma	NT2E	NOT.W D4
B p	B LABEL1	BRA LABEL1	NTM v	NTM BYT1	NOT.B BYT1
Baf i2	BGN 8	BCLR #8,D6	NXma	NX4F	NEGX.L D5
Bafb	BHOF	BSET D5,D7	NXM v	NXM 1MS	NEGX.B (A7)
BaT i2	BET \$10	BTST \$10,D4	O v, i	O 2G,\$AA	OR.W # \$AA,D6
BaTh	BDTC	BTST D2,D3	Oa v	OH BYT1	OR.B BYT1,D7
Bcc p	BEQ BETA	BEQ BETA	OCC i1	OCC 8	OR.B #8,SR
Bf v1, i2	BX M9,6	BCHG #8,M9	OMa v	OMB 4MUI	OR.L D1,(A5)+
Bfa v1	BNB 1MTI	BCLR D1,(A6)+	OSR i2	OSR \$200	OR.W # \$200,SR
BS p	BS PROG3	BSR PROG3	PA v	PA 1MV	PEA (A4)
BT v1, i2	BT M8,3	BTST 3,M8	PH v	PH WD1 MOVE.W WD1,-(A7)	
BTa v1	BTM 1MDZ	BTST D0,-(A0)	PL v	PL 4A MOVE.L (A7)+,D0	
C v, i	C 4MSI,5	CMP.L #5,(A7)+	PMxa Q(t)	PM2B J(Z)	MOVEP.W D1,J(A0)
Ca v	CD 1A	CMP.B D0,D3	Pxa Q(t)	P4C J(Y)	MOVEP.L J(A1),D2
CKa v2	CKB WD1	CHK WD1,D1	R	R	RTS
Cmtu	C4YZ CMPM.L (A0)+,(A1)+		RE	RE	RTE
Ct vx	CK 2W	CMP.W A3,A2	RM rs, vx	RM T,LW1	MOVEM.L A6,LW1
Dcca p	DGSC L19	DBCS D2,L19	RMxt rs	RM4Z T-Y	" A1-A6,-(A0)
Dsa v2	DSD WD1	DIVS WD1,D3	ROd v2	ROR WD1	ROR WD1
DUA v2	DUE 2MU	DIVU (A5),D4	ROd ma, sc	ROL 1D,C	ROL.B D2,D3
Ea	EF	SWAP D5	RR	RR	RTR
Egh	ESA	EXG A7,D0	RS	RS	RESET
FAt -i2	FAZ -23	LINK A0,-23	RXd v2	RXL WD1	ROXL WD1
Fdt	FDT	UNLK A6	RXd ma, sc	RXR 4E,6	ROXR.L 6,D4
H i2	H \$FOFO	STOP \$FOFO	S v, i	S 1MW,32	SUB.B #32,(A3)
J v	J 1MYD-8	JMP -8(A1,D3)	Sa v SA	2MX4G-8 SUB.W -8(A2,D6.L),D0	
JS v	JS 1MX4G	JSR (A2,D6.W)	Sbab	SBFE	SBCD D4,D5
Lat v	LAW 1MVI	LEA (A4)+,A3	Sbtu	SBZY	SBCD -(A1),-(A0)
Lsd v2	LSL WD1	LSL WD1	Scc v1	SGT BYT1	SGT BYT1
Lsd ma, sc	LSR 1F,H	LSR.B D7,D5	SMA v	SME 4MWH	SUB.L D4,0(A3,D7)
M v, w	M LW1,J3	MOVE.L J3,LW1	St vx	SU 2F	SUB.W D5,A5
Ma v	MC 2,#\$C	MOVE.B # \$C,D2	SXmab	SX4HB	SUBX.L D1,D7
MCC v2	MCC \$1A	MOVE \$1A,CCR	SXmtu	SXLUS	SUBX.B -(A7),-(A5)
MKa k	MKH -100	MOVEQ -100,D7	Sn v	S7 2MTI	SUBQ.W #7,(A6)+
MMa v	MMA WD2	MOVE.W D0,WD2	TE v	TE 1MV4X	TST.B 0(A4,A2.W)
MMt vx	MMV 4MU	MOVE.L A4,(A5)	TR vn	TR 4	TRAP 4
MR rs, vx	MR T,LW1	MOVEM.L LW1,A6	TS v1	TS 1G	TAS D6
MRxt rs	MR4Z A/H	" (A0)+,D0/D7	TV	TV	TRAPV
MSa v2	MSB 2MDW	MULS -(A3),D1	X v, i	X 1MW,\$FF	EOR.B # \$FF,(A3)
MSM v2	MSM 2MVI	MOVE SR,(A4)+	XCC i1	XCC \$2	EOR.B # \$2,SR
MSR v2	MSR 2MU	MOVE (A5),SR	XMa v	XMD LW1	EOR.L D3,LW1
MSt	MSX	MOVE A2,USP	XSR i2	XSR \$400	EOR.W # \$400,SR
Me vx	MY 2MZ	MOVE.W (A0),A1	Xxa	X4C	EXT.L D2
MeS	MUS	MOVE USP,A5	Z v	Z 1MZ4Y+2	CLR.B 2(A0,A1.W)
MUa v2	MUC WD3	MULU WD3,D2			

Table IV

An example which shows the bug is that of a table of size greater than \$82 (that is, hexadecimal 82), which is already sorted in descending order except that its last two bytes are \$FF (and no other byte is \$FF). In the given program, these final two bytes move up by one position in each pass through the table; and only two exchanges (the ones involving these two bytes) are made in each pass, since the table is otherwise already sorted in the proper order. Therefore, MB and A1 are executed only twice in each pass through the table. In the first pass, \$FF is moved into B and this is then incremented by 1 as a two-byte quantity, producing \$100. Subsequently, \$FF is moved into the *rightmost byte* of B, leaving the rest of B undisturbed; this produces \$1FF, which is then incremented to \$200. Thus the final value of B is \$200 at the end of the first pass, and, in general, it is 2 x \$k00 at the end of the kth

pass. At the end of the 128th pass, therefore, B will be zero; the TE then tests for zero; the BNE does *not* branch back; and the sort terminates with the two \$FF bytes in positions 129 and 130 from the end, instead of in the first two positions, where they belong.

References

- ¹ Kane, G., D. Hawkins, and L. Leventhal, *68000 Assembly Language Programming*, Osborne/McGraw-Hill, Berkeley, 1981.

DDJ

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PGM_9_4A	MZ	LIST	(Move LIST, which is a 4-byte quantity, to the Z-register)
	Z	2A	(Zero, or clear, two bytes of the A-register)
	MA	1MZI	(Move, to the A-register, one byte of memory, indexed by the Z-register, and then increment the Z-register by 1)
	LAY	1MZA-1	(Load into the Y-register the address in memory indexed by the Z register and by the A register, minus 1)
SORT	Z	2B	(Zero, or clear, two bytes of the B-register)
	MX	4Z	(Move, to the X-register, four bytes of the Z-register)
NEXT	MA	1MXI	(Move, to the A-register, one byte in memory, indexed by the X-register, and then increment the X-register by 1)
	CA	1MX	(Compare the A-register with one byte in memory, indexed by the X-register)
	BCC	NSWITCH	(Branch on carry clear to NSWITCH)
	MB	1MX	(Move, to the B-register, one byte in memory indexed by the X-register)
	MMB	1MX-1	(Move to memory, from the B-register, to one byte in memory, indexed by the X-register minus 1)
	MMA	1MX	(Move to memory, from the A-register, to one byte in memory, indexed by the X-register)
	A1	2B	(Add 1 to two bytes of the B-register)
NSWITCH	CY	4X	(Compare the Y-register with four bytes of the X-register)
	BHI	NEXT	(Branch on high, i. e., Y > X, to NEXT)
	TE	2B	(Test two bytes of the B register)
	BNE	SORT	(Branch to SORT on unequal to zero)
	R		(Return from subroutine)

REGISTERS

OLD	D0	D1	D2	D3	D4	D5	D6	D7	A0	A1	A2	A3	A4	A5	A6	A7
NEW	A	B	C	D	E	F	G	H	Z	Y	X	W	V	U	T	S

Table V

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CP/M REVIEW

THE PUBLICATION FOR THE CP/M COMMUNITY

by Gene Head

Mail received after the first CP/M Exchange was encouraging. There is heavy interest in modem communication and program exchange. The most often asked question was, "How do I get started using my modem?" Well, it may be as simple as one, two three. I say *may* because each modem installation is different. If you have a basic understanding of the following three steps, you should be able to get signed-on to a Remote CP/M (RCP/M) System using the MBOOT3 program (listing begins on page 47).

1. Modem Status
2. Modem Input
3. Modem Output

If you understand how the CP/M functions CONSOLE STATUS, CONSOLE INPUT and CONSOLE OUTPUT operate, you also understand how the modem should operate. (Note: CONSOLE routines use only seven bits of data and the MODEM routines *must* use all eight bits.) Don't be put off if you fail

to understand how to get the CP/M CONSOLE functions to operate. You'll need special assistance to get your modem functional, but I have a plan for you too!

MBOOT3 is a simple, stripped-down, receive-only version of Ward Christensen's MODEM program. The idea is to get MBOOT3 operating and use it to download (receive) a full MODEM program from an RCP/M system. If you have a modem, the software to simulate a terminal *and* the ability to "capture" received data into a file, just log on to an RCP/M and command the remote computer to list the MBOOT3 file using the CP/M command TYPE. Otherwise, spend an hour or so and type in MBOOT3.

Customize the hardware-dependent equates, assemble, and load MBOOT3. Follow the instructions on the facing page, remembering that each RCP/M system may be slightly different. Use your head. Don't be discouraged. Try to get the SYS-

tem OPERATOR's help by using the CHAT command, or try ringing his bell by typing control-G. You can't hurt the remote system, and every RCP/M I've ever used has been very forgiving of errors and even untimely disconnections.

Modem Hint # 1

You will probably need cooperation from someone with a modem to test your system out before making long-distance calls to RCP/M's. If you can't get that special help, consider this: colleges with computer departments usually have a modem telephone for remote users. Without an account number and/or password you can't do much but you can at least verify that the basic communication, modem-to-modem, is operating. Execute the MBOOT3 program as directed in the source listing and then access any modem line by telephone. Try a few carriage returns to get the remote system "talking" to your system. Words like FULL and

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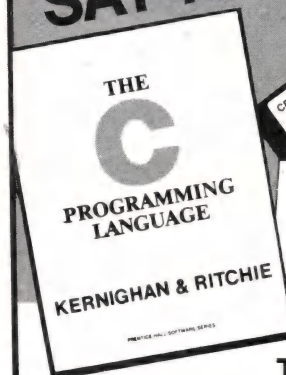
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Special Assistance

Here is where the novice can be helped by the experienced modem user. If you have the MODEM program working on your system, send me a card with all the details about your specific hardware, the source listing of *just the hardware-dependent equates* and any unique hardware-dependent code, and how they are configured for your set-up.

Likewise, if you have the hardware but don't know exactly how to customize the software, send me a card with your specific hardware specifications. (Keep it simple!) I'll match your request with a known working system and send you the customization details. If I can't get an exact match, I'll send along the best data I have available. *Be sure to enclose an SASE with your request.* I'll do free photocopying (but no free postage) as long as this doesn't get too involved. . .

If you can offer help or need help, let the "CP/M Exchange" know! Be sure to include your disk format and complete modem configuration. Send your complete name, address, city, state, zip, and phone with area code.

Exchange Mail

The first response to the CP/M Exchange came from DDJ contributor Bob Blum. Bob suggested electronic mail for communication. If the interest is there, we might be able to compile a directory of those using this form of communication. I will make my RCP/M system available if there is serious interest. Anyone else have ideas along these lines? Bob is also preparing a contribution on keyboard buffering in a modified CCP for CP/M that will be included in a future "CP/M Exchange."

The most specific letter seeking help came from Charles Henderson of Midland, Texas. Charles is interested in why SPEED and FAST won't work with CP/M 2.x. He suspects the track buffering is involved but doesn't understand all the implications. A definitive article on track and sector skewing, interleaving, sector tables, etc. would be most appropriate. If you have a solid understanding of these principles, write a paper and send

it in! Share with others what you have learned.

Dana Trout of Goleta, California, notes that CP/M Function #37 does not work as described in the manual. This function to reset the disk drives will reset all drives *except* the current default drive. If the current default drive is set to R/O and function thirty-seven is executed, the default drive is still in R/O! Anyone have a fix and/or explanation for this?

Roland Lupient, KB9RR, has ham radio gear, an Altair 8800 and CP/M User's Group volume 41. He would like to hear from anyone who can help interface the ham gear and computer (address: 1953 Graham Lane, Mosinee, WI 54455).

Finally, William Burnett of Sinton, Texas, wonders if there are any Super-

brain users out there who have access to the CP/M User's Library? The same question can be asked about North Star, Osborne, and all the other five-inch formats. If you can copy the CP/M User's Library to any of the many five-inch disk formats, let me know. I suspect you will be in great demand, and while you may not make a lot of money at this, a couple of bucks copying fee seems reasonable.

That covers it for now. Every letter to the "CP/M Exchange" has received either a personal response or was noted in this column. If you have something to contribute, a question or comment, let's hear from you!

DDJ

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Downloading MODEM Using MBOOT3

First, execute MBOOT3 as instructed in the source listing (begins on page 47). It will sign on, but there will be no screen activity after the sign-on messages. In the TERMINAL mode, all displayed console characters come from the remote system. Even keys from your keyboard are "echoed" back, so if there is no remote system to echo back the keystrokes, you won't see them on your CRT.

Now, call a remote CP/M System (see list on page 44), when you hear the remote modem carrier tone, connect your modem to the phone line. The two modems are now connected and your computer is "talking" to the remote computer. Press the Return key once a second until you see the remote computer's sign-on message, usually asking how many nulls you need. (Answer 0 to the nulls question if you're using a video terminal.)

Follow the host computer's instructions until you finally reach the CP/M operating level with the expected A>. You are now in control of the remote machine.

To find the MODEM program type:

DIR MODEM *.*

This will show you the exact name of the MODEM files available. You should see in the listing the MODEM.ASM file or some similar source code file.

To receive the file type:

XMODEM filename.type

The remote system should tell you that XMODEM is ready to send the requested file, then it will wait. There will be no further screen activity from the host computer. It will look as though you have lost control, but don't fret. The host is waiting for your MBOOT3 program to send special protocol characters to begin the transfer and won't respond to your keyboard characters until the transfer is completed or aborted.

Now that you know the host is ready to send and is waiting for you to be ready to receive, press your ESCape key. This key tells MBOOT3 to receive the file the host is sending.

Most CP/M commands are available to remote users, so use the remote system just as you would your local computer. Be sure to sign off by typing BYE and disconnect your modem from your phone line, if it isn't automatically disconnected by your software.

As with any new operation, practice and experience are the best teachers.

Remote CP/M Software Exchange Systems List # 24

Last Revised March 21, 1982

List #24 revised and updated courtesy of Hyde Park RCPM, CP/M-Net, and Mississauga RCPM.

This is part of a CP/M file called RCPMLIST.xx. It is found on most RCP/M systems. The systems presented here are representative of what you can expect to find. Each was "up" as of February, 1982, unless otherwise noted. Log on to any system and then get a copy of this complete file for an accurate directory.

This is a partial list.

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Larkspur RBBS/RCPM (415) 461-7726, Jim C.
24 hour operation
Up as of 3/20/81
110, 300, 450, 710 baud; SPRINT, ITT, MCI
2+ Mb on 2 drives
The system carries general and new CP/M software. System
now running MP/M and plans are afoot to install a
second telephone line, making it the first multi-user
remote system. SYSOP will assist others in bringing up
MP/M remotely.

Palos Verdes, CA

G.F.R.N. Data Exchange RBBS, (213) 541-2503,
Skip Hansen
24 hour operation
300 and 1200 baud; SPRINT, MCI, ITT
2.4 Mb of files on 2 drives
Standard CP/M software with special interest in ham radio-
related programs. Soon (with MP/M) will also be reach-
able through 450 MHz radio.

San Diego, CA

San Diego RCPM, (714) 271-5615, Brian Kantor
No call back; 24 hour operation
300 and 1200 baud; ITT, SPRINT, MCI
2.4 Mb of files on 2 drives
Now with 212-compatible modem; yet another 1200-baud.

East Central

Allentown, PA

Allentown RBBS/RCPM System, (215) 398-3937,
Bill Ernest
No call back; 24 hour operation
110, 300, 450, 600, 710 baud; SPRINT and ITT
4.25 Mb of files on hard disk (=4 logical disks)
General CP/M software. Bulletin board of the Lehigh
Valley Computer Club.

Grafton, VA

Grafton, VA RBBS, (804) 898-7493, Dave Holmes
No call back, no A.L.D.S.; 24 hour operation
300 baud
200 Kb of files on 2 drives
Carries CP/M, TRS-80 and Apple software; plans for
setting up a dual system (on one line) with an LNW-80
as well as the CP/M computer. Active as bulletin board.

McClean, VA

RLP RCP/M, McClean, VA, (703) 524-2549, Bob Plouffe
No call back; 24 hour operation
SPRINT and MCI
4 (N*) drives with 640 Kb of files
Running CBBS for messages. New system.

Midwest

Chicago (area), IL

Calamity Cliffs Computer Center, (312) 234-9257
No call back; 1400-0200 daily
300, 450, 600 baud; ITT, SPRINT, MCI
11 Mb of files on a hard disk and 2 floppies
Many of the CPMUG and SIG/M programs available by
request.

Chicago, IL

HUG-CBBS, (312) 671-4992, Paul Mayer, Dave Leonard
No call back; 2300 to 1900, 7 days/week
300 baud; SPRINT, ITT, MCI
2 Mb of files on 2 drives
H89-based, operated for the Heath-Zenith Users' Group
and with a special interest in H19- and H89-adapted
(as well as general CP/M) software.

Hyde Park, IL

Hyde Park RCPM/RBBS, (312) 955-4493, Ben Bronson
No call back; 0100-1700 daily
110, 300, 450, 600, 710 baud; SPRINT, ITT, MCI
2 Mb of files on 2 drives
Special interest in hardware and software reviews, C pro-
grams, and very recent releases of standard programs.
SYSOP now testing substantial upgrade of RBBS
programs.

Royal Oak, MI

Royal Oak CP/M, (313) 759-6569, Keith Petersen

Call back; 24 hour operation

110, 300, 450, 600 baud — 1200 baud modem now available on request; use CHAT or leave a message if you want the 212A switched in — ITT, SPRINT, MCI
600 Kb on two floppy drives and 10 Mb on hard disk (=2 logical drives)

Emphasis on new programs and recent updates of standard programs.

Westland, MI

Westland, MI RBBS/RCPM, (313) 729-1905, Ron Fowler
Call back; 24 hour operation
110, 300, 450 and 600 baud; SPRINT, MCI, ITT
1.4 Mb of files on 2 drives
Emphasis on very recent releases.

Northeast

Lexington, MA

Superbrain RCPM, (617) 862-0781, Paul Kelly
1900-0700 Weekdays, 24 hours weekends
110, 300, 1200 baud; SPRINT, ITT, MCI
300 Kb files on-line
Special interest in Superbrain-adapted CP/M programs.

Bearsville, NY

Bearsville Town SJBBS, (914) 679-6559, Hank Szyszka
No call back, no A.L.D.S.
110, 300, 450, 600, 710 baud
2 Mb of files on 4 drives
Installing MP/M. All CP/MUG programs available by request. General CP/M software.

Rochester, NY

Rochester RBBS, (716) 223-1100, Arnie McGall
No call back; 24 hour operation
110 and 300 baud; SPRINT, MCI, ITT
1.8 Mb of files on 3 drives
S-100 based. General CP/M software. The standard RBBS/RCPM system co-exists with a separate passworded message system called DataStar, which can be entered from CP/M but runs on a separate computer. 600 baud capability expected soon.

Hamilton, ON

Hamilton Area Packet Radio Network (HAPN), (416) 335-6620, Stu Beal
No A.L.D.S.; 24 hour operation
110, 300, 450, 600, 710 baud
@? Kb files on-line
New system. System is also linked to radio network and may be accessed via ham radio. Special interest in radio software.

Toronto, ON

Mississauga, Ontario RCPM, (416) 826-5394, Jud Newell
No A.L.D.S.; 24 hour operation
110, 300, 450, 600, 710, 1200 baud
20 Mb hard disk now on-line 24 hours a day
1200 baud Vadic/Bell 212A standard both supported.
300/1200 baud modem available Monday-Friday, PMMI weekends. XMODEM, DISKMENU.DOC and MAST.CAT for details of over 3000 available files.

(Continued on page 46)

Q/C Leads the Pack.



Q/C leads the pack of C compilers for CP/M. For only \$95 you get an excellent compiler that is fully supported. And Q/C includes the *full source code* to the compiler! The 88-page manual sets standards for readability and clarity. (There is even a chapter on compiler internals.)

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CP/M Exchange (Continued from page 45)

System now restricted to CP/M users only by use of a familiarity question.

Toronto, ON

Mississauga, Ontario HUG-RCP/M, (416) 273-3011
No A.L.D.S.; 1800-0600 weekdays, 24 hours weekends
110, 300, 450, 600, 710 baud
2+ Mb of files on 5 drives
Toronto Heath Users' Group.

South

Huntsville, AL

NACS/UAH RBBS/RCPM, (205) 895-6749, Don Wilkes
Call back, no A.L.D.S.; 24 hour operation
110, 300, 450, 600 baud
700 Kb files on 4 drives
Run for North Alabama Computer Society at University of Alabama; general CP/M software.

Louisville, KY

Louisville RBBS/RCPM, (502) 245-7811, Mike Jung
No call back; 0900-2100 weekdays, 24 hours weekends
300 baud; SPRINT, MCI
2.5 Mb of files on 5 drives
Heath/Zenith-based. Emphasis on BASIC software. Some HDOS stuff available for downloading.

Fort Mill, SC

Fort Mill RIBBS, (803) 547-6576, Bill Taylor
Up as of 08/15/81
No call back, no A.L.D.S.; 24 hour operation
300 and 1200 baud
3 Mb of files on 2 drives
Heath/Zenith-based with 212-compatible modem. The system carries ham stuff, general software, and on-line games. The fourth 1200-baud RCM.

DDJ

(Listing begins at right)

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The complete professional software system, that meets ALL provisions of the FORTH-79 Standard (adopted Oct. 1980). Compare the many advanced features of FORTH-79 with the FORTH you are now using, or plan to buy!

FEATURES	OURS	OTHERS
79-Standard system gives source portability.	YES	_____
Professionally written tutorial & user manual	200 PG.	_____
Screen editor with user-definable controls.	YES	_____
Macro-assembler with local labels.	YES	_____
Virtual memory.	YES	_____
Both 13 & 16-sector format.	YES	_____
Multiple disk drives.	YES	_____
Double-number Standard & String extensions.	YES	_____
Upper/lower case keyboard input.	YES	_____
LO-Res graphics.	YES	_____
80 column display capability	YES	_____
Z-80 CP/M Ver. 2.x & Northstar also available	YES	_____
Affordable!	\$99.95	_____
Low cost enhancement option:		
Hi-Res turtle-graphics.	YES	_____
Floating-point mathematics.	YES	_____
Powerful package with own manual, 50 functions in all, AM9511 compatible.		
FORTH-79 V.2 (requires 48K & 1 disk drive)		\$ 99.95
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FEATURES	OURS	OTHERS
79-Standard system gives source portability.	YES	_____
Professionally written tutorial & user manual.	200 PG.	_____
Screen editor with user-definable controls.	YES	_____
Macro-assembler with local labels.	YES	_____
Virtual memory.	YES	_____
BDOS, BIOS & console control functions (CP/M).	YES	_____
FORTH screen files use standard resident file format.	YES	_____
Double-number Standard & String extensions.	YES	_____
Upper/lower case keyboard input.	YES	_____
APPLE II/II+ version also available.	YES	_____
Affordable!	\$99.95	_____
Low cost enhancement options;		
Floating-point mathematics	YES	_____
Tutorial reference manual		
50 functions (AM9511 compatible format)		
Hi-Res turtle-graphics (NoStar Adv. only)	YES	_____
FORTH-79 V.2 (requires CP/M Ver. 2.x).		\$99.95
ENHANCEMENT PACKAGE FOR V.2:		
Floating point		\$ 49.95
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Circle no. 19 on reader service card.

(Text begins on page 42)

```

IF      STDCPM
ASE      EQU      0
ENDIF

```

(Continued on column 2)

(Continued on next page)

MBOOT.ASM

(Listing continued, text begins on page 42)

```

FCB      EQU      BASE+5CH
;
;      ORG      BASE+100H
;
;      LXI      H,0
;      DAD      SP
;      SHLD     STACK
;      LXI      SP,STACK
;      CALL     INITADR
;      CALL     ILPRT
;      DB      'MBOOT as of '
;      DB      '11/5/80',CR,LF,0
;      LDA      FCB+1
;      .
;      CPI      0
;      JNZ      ILPRT
;      CALL     ILPRT
;      DB      'END FILE NAME SPECIFIED++',CR,LF,0
;      JMP      EXIT
;
;      CALL     INITMOD
;      IN        MODDATP
;      IN        MODDATP
;      CALL     ILPRT
;      DB      CR,LF,'TERMINAL MODE',CR,LF
;      DB      'CTL-E exits to CP/M, ESC starts file transfer',
;      DB      CR,LF,0
;
;      CALL     STAT
;      JZ        TERM
;      CALL     KEYIN
;      CPI      EXITCHR
;      JZ        EXIT
;      ESC
;      CPI      0
;      JZ        RCVFIL
;      OUT       MODDATP
;
;      IF NOT DCH
;      IN        MODCTL1P
;      ENDDIF
;
;      IF DCH
;      IN        MODCTL2
;      ENDDIF
;
;      ANI      MODRCVB
;      CPI      MODRCVR
;      JNZ      TERM
;      IN        MODDATP
;      ANI      7FH
;      CALL     TYPE
;      JMP      TERM
;
;      RCVFIL
;      CALL     ERASFIL
;      CALL     MAKEFIL
;      CALL     ILPRT
;      DB      'FILE OPEN, READY TO RECEIVE',CR,LF,0
;
;      RCVLP
;      CALL     RCVSECT
;      JC        RCVBOT
;      CALL     WRSECT

```

(Continued on top of page 48)

```

INCRSND
CALL     SENDACK
RCVLP
;
;      RCVBOT
;      CALL     WRBLOCK
;      CALL     SENDACK
;      CALL     CLOSFIL
;      CALL     ERXIT
;      DB      CR,LF,'TRANSFER COMPLETE$'
;
;      A
;      ERCT
;
;      B,10
;      RCV
;      RCVSERR
;      JC        SOH
;      RCVSOH
;      A
;      RCVRPT
;      EDT
;      STC
;      RZ
;
;      RCVSERR
;      MVI      CALL
;      JNC      RCVSERR
;      MVI      A,NAK
;      SEND
;      LDA      ERCT
;      A
;      STA      INR
;      CPI      0
;      JC        RCVRPT
;
;      CLOSFIL
;      ERXIT
;      DB      '++UNABLE TO RECEIVE BLOCK',
;      DB      CR,LF,'++ABORTING++$'
;
;      B,1
;      RCV
;      RCVSERR
;      D,A
;      MVI      B,1
;      RCV
;      RCVSERR
;      D
;      RCVDATA
;      RCVSERR
;      A,D
;      RCVSND
;      C,0
;      H,BASE+80H
;
;      B,1
;      RCV
;      RCVSERR
;      M,A
;      L
;      RCVCHR
;      D,C
;      B,1
;      RCV
;      CALL

```

(Continued on page 49, column 1)


```

JC      RCVERR
CMP      D
JNZ      RCVERR
LD      RCVSND
MOV      B,A
SECND    B
CMP      B
JZ       RCVACK
INR      A
CMP      B
JNZ      ABORT
RET

; RCVACK CALL
; SENDACK JMP
; SENDACK MVI A,ACK
; SEND PUSH
; ADD C
; MOV C,A
; IF NOT DCH
; IN MODCTL1
; ENDIF
; IF DCH
; IN MODCTL2
; ENDIF
; ANI MODSND
; CPI MODSND
; JNZ SENDW
; POP PSW
; OUT MODDATP
; RET
; ABORT LXI SP,STACK
; ABORTL MVI B,1
; CALL RCV
; JNC ABORTL
; MVI A,CAN
; CALL SEND
; ABORTW MVI B,1
; CALL RCV
; JNC ABORTW
; MVI A,
; SEND
; CALL ERXIT
; DB 'BOOT PROGRAM CANCELLED*'
; INCRSND LDA
; INR
; STA
; RET
; ERASFIL LXI
; MVI C,17
; CALL BDO
; INR A
; RZ
; CALL ILPRT
; DB '++FILE EXISTS, TYPE Y TO ERASE:',0

```

(Continued on column 2)

```

CALL PSW
PUSH TYPE
CALL CRLF
POP PSW
ANI SFH
Y'
MXT
D,FCB
C,19
BDO
MAKEFIL LXI
MVI C,22
CALL BDO
INR A
ERXIT
'++ERROR - CAN'T MAKE FILE',CR,LF
'++DIRECTORY MUST BE FULL$'
D,FCB
C,16
BDO
A
ERXIT
'++CAN'T CLOSE FILE$'
; WRSECT LHL
; XCHG
; LXI
; CALL
; INR
; RZ
; CALL
; DB
; DB
; CLOSFIL LXI
; MVI C,16
; CALL BDO
; INR
; RZ
; CALL
; DB
; DB
; WRSECT LHL
; XCHG
; LXI
; CALL
; INR
; RZ
; CALL
; DB
; DB
; 2STA
; CPI 16
; RZ
; WRBLOCK LDA
; ORA
; RZ
; MOV C,A
; LXI D,DBUF
; DKWRLP PUSH
; PUSH
; PUSH
; MVI C,26
; CALL BDO
; LXI D,FCB
; MVI C,21
; CALL BDO
; POP
; POP
; POP
; ORA
; JNZ
; LXI
; XCHG
; DCR
; JNZ
; XRA
; STA
; SECINBF

```

(Continued on column 3)

```

; RSDMA LXI SHLD
; MVI D,BASE+80H
; JMP C,26
; BDO
; WRERR RSDMA
; CALL ILPRT
; DB '++ERROR WRITING FILE',CR,LF,0
; JMP ABORT
; REC D
; IF FASTCLK
; MOV A,B
; ADD A
; MOV B,A
; ENDIF
; MSEC LXI D,50000
; IF NOT DCH
; IN MODCTL1
; ENDIF
; IF DCH
; IN MODCTL2
; ENDIF
; ANI MODRCVB
; CPI MODRCVR
; JZ MCHAR
; DCR E
; JNZ MWTI
; DCR D
; JNZ MWTI
; DCR B
; JNZ MSEC
; POP D
; STC
; RET
; MCHAR IN MODDATP
; POP D
; PUSH PSW
; ADD C
; MOV C,A
; POP PSW
; ORA A
; RET
; INITADR LHL
; LXI D,3
; DAD D
; SHLD VSTAT+1
; DAD D
; SHLD VKEYIN+1
; DAD D
; SHLD VTYPE+1
; RET
; INITMOD EQU $
; IF INITREQ

```

(Continued on next page)

16-BIT SOFTWARE TOOLBOX

by Ray Duncan

Late News for 8087 Fanciers

Intel recently dropped the price of the Intel 8087 numeric processor to \$230 in single-unit quantities. Some high-level software tools to exploit the 8087 are also beginning to appear. In addition to my own company's version of Forth which can use the 8087 co-processor, Lifeboat Associates is marketing the Lattice C Compiler which includes an 8087 runtime library, and rumor tells of a UCSD Pascal support file named 8087.PLS which is not yet officially announced.

16-Bit Tools, Installment # 2

The accompanying listing is an 8086/88 assembly language subroutine that returns the sine or cosine of an angle to four significant digits. The precision is adequate for most graphics applications, and the routines are implemented by a combination of deduction and table-lookup techniques that are extremely fast. The original version of these routines was coded in Forth by John James and placed in the public domain; interested

readers are referred to his article in *Forth Dimensions*, volume 4, no. 1.

Readers who also need a tangent function can derive it easily:

$$\tan(x) = \frac{\sin(x) * 10000}{\cos(x)}$$

But watch out: finding tangents in this way for angles greater than seventy-two degrees will lead to a divide overflow, which causes a hardware interrupt on the 8086/88.

A more precise (but slower) method of finding sine, cosine and tangent through a simple polynomial expansion will be presented in a later column.

Product Report: Microsoft RAMCard with RAMDrive

This integrated combination of hardware and software can be installed in any IBM Personal Computer, and will markedly enhance its operation. "RAMDrive" refers to a technique of mapping a disk directory and file structure onto a portion of the machine's random access memory.

The operating system drivers are modified so that the simulated disk can be accessed by application programs like any other peripheral device. Since there are no moving parts, data can be retrieved nearly instantaneously. As many as three RAMCards may be installed, yielding a maximum of 768 Kbytes of RAMDrive storage.

The package contains a memory expansion board of average-quality construction socketed for 256 Kbytes with parity, a diskette of utility programs and a sixty-page manual. The product is available in several versions and prices, depending on the amount of RAM initially supplied. The user can upgrade a partially filled card by simply plugging in more dynamic memory chips.

Installing the memory card in the IBM PC is quite simple, and can be done in a few minutes by anyone who can read and handle a screwdriver. The manual is clear and complete, and has plenty of helpful troubleshooting tips.

Next, you use a memory test provided on the Microsoft diskette to make sure

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If you feel that you must have proportional-spacing, justification, etc. there are good word processors in the \$75-500 range. But for most users, Micro-WYL represents an incredible bargain. It is easy to learn, easy to use, and incredibly powerful. **Send your check today - we'll ship within 48 hours of receipt.**

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☐ Apple/Softcard

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the RAMCard is working properly. This program is a classic of its kind. It was obviously written by a programmer who was told to make the product "user-friendly," and who thought he could meet that objective with liberal use of reverse-video, blinking text, complicated screen-oriented presentations and, of course, using the special-function keys at any cost. For example, the user is asked to respond to one of the program's setup questions by pushing either the F9 function button or the space bar, neither of which are conveniently located or have the slightest mnemonic value. In spite of its veneer of razzle-dazzle, the program suffers from major design faults in the human interface that make it awkward to use, such as a lack of backspace capability should you be unfortunate enough to make an error in numeric entry. The program and documentation don't provide the smallest morsel of information about the testing process itself, and the only way to terminate the test once it is running is to reset the computer. This is not my idea of a classy program.

After you are convinced that the memory card is working correctly, you run the configuration program, which patches the PC-DOS operating system and makes the extra memory available as a simulated disk device. This is a simple procedure and requires only a few seconds — afterwards, you can copy the revised operating system to your various working disks. You might wonder what would prevent someone from pirating the configuration programs and using them with other companies' less-expensive memory cards. Never fear, Microsoft has provided against this eventuality: part of the necessary software is in a programmed read-only memory chip installed right on the RAMCard.

Using the RAMDrive capability can result in astonishing improvements in performance for programs which are disk I/O bound. For example, a simple Forth program to sequentially read through a 100 Kbyte file, accessing it as 1024-byte records, completed in 24.9 seconds using a regular 5¼-inch floppy disk drive but only required one second on the RAM-

Drive.

The RAMCard and RAMDrive package costs \$495 with 64Kbytes installed, and each additional 64Kbytes costs you \$200 from Microsoft up to a grand total of \$1095 for a complete 256Kbyte card. Here is where a little careful shopping can save you a bundle of money. I bought the minimum 64Kbyte card from Microsoft via Computerland, and obtained the twenty-seven dynamic RAM (type 4164) chips necessary to fill up the card for \$227 from BG Micro in Garland, Texas. Thus, I saved \$373 as compared to buying the RAM expansions from Microsoft.

Note that if you do not want the RAMDrive feature of this product, there are many memory cards available from reputable companies at considerably lower cost. But if you really need increased speed from your IBM PC, but aren't yet ready to take the plunge on a hard disk, then this product is great!

(Listing begins at right)

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8086 Trig

(Text begins on page 51)

```

title 'Trig Lookup Functions'
pagewidth 79

;
; Trig lookup functions for 8086/88
; adapted by Ray Duncan from a public
; domain FORTH routine written by John James.
;
; 'Trig' is a common routine used by 'sin'
; and 'cos' to reduce an angle into the
; range 0-90 degrees then extract the
; appropriate function value from the table.
;
0000 8BDB      trig:  mov     bx,ax      ;bx <- degrees
0002 83FB5A    cmp     bx,90      ;if > 90 degrees
0005 7E06      000D    jle     trig1    ;reduce the angle
0007 B1EBB400  sub     bx,180
000B F7DB      neg     bx
000D D1E3      trig1: sal     bx,1      ;table index = 2*deg.
                                ;now extract value
000F 2EBB873F00 mov     ax,sintbl[bx]
0014 C3        ret              ;back to caller

;
; Cosine lookup: add 90 degrees to
; argument and use sine lookup.
; call with:      ax = degrees
; returns:       ax = cosine * 10000
; other registers preserved.
;
0015 055A00    cos:  add     ax,90

;
; Sine lookup: reduce to angle in
; range 0-359 degrees, then call
; 'trig' to extract function value
; from table.
; call with:      ax = degrees
; returns:       ax = sine * 10000
; other registers preserved.
;
0018 52        sin:  push     dx      ;save registers
0019 53        push     bx
001A 99        cwd         ;deg -> double prec.
001B BB6B01    mov     bx,360      ;reduce angle to
001E F7FB      idiv     bx        ;range 0-359 degrees
0020 8BC2      mov     ax,dx      ;let ax=remainder
0022 0BC0      or      ax,ax      ;is angle negative?
0024 7903      0029    jns     sin2    ;no, jump
0026 056B01    add     ax,360      ;yes, make it positive
0029 3DB400    sin2:  cmp     ax,180 ;now reduce angle to
002C 7E0B      0039    jle     sin3    ;range 0-180 degrees
002E 2DB400    sub     ax,180      ;angle was > 180 deg.
0031 EBCCFF    0000    call    trig    ;look up function value

0034 F7DB      neg     ax
0036 E90300    003C    jmp     sin4
0039 EBC4FF    0000    sin3:  call    trig    ;angle was <= 180 deg
003C 5B        sin4:  pop     bx      ;restore registers
003D 5A        pop     dx
003E C3        ret              ;back to caller

;
; lookup table for trig functions
;
003F 0000      sintbl dw     0      ;0 degrees
0041 AF00      dw     175      ;1
0043 5D01      dw     349      ;2
0045 0B02      dw     523      ;3
0047 BA02      dw     698      ;4
0049 6803      dw     872      ;5
004B 1504      dw     1045     ;6
004D C304      dw     1219     ;7
004F 7005      dw     1392     ;8
0051 1C06      dw     1564     ;9
0053 C806      dw     1736     ;10
0055 7407      dw     1908     ;11
0057 1F08      dw     2079     ;12
0059 CA08      dw     2250     ;13
005B 7309      dw     2419     ;14
005D 1C0A      dw     2588     ;15
005F C40A      dw     2756     ;16
0061 6C0B      dw     2924     ;17
0063 120C      dw     3090     ;18
0065 B80C      dw     3256     ;19
0067 5C0D      dw     3420     ;20

```

(Continued on next page)

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8086 Trig

(Listing continued, text begins on page 51)

```

0069 000E      dw      3584      j21
006B A20E      dw      3746      j22
006D 430F      dw      3907      j23
006F E30F      dw      4067      j24
0071 B210      dw      4226      j25
0073 2011      dw      4384      j26
0075 BC11      dw      4540      j27
0077 5712      dw      4695      j28
0079 F012      dw      4848      j29
007B B813      dw      5000      j30
007D 1E14      dw      5150      j31
007F B314      dw      5299      j32
0081 4615      dw      5446      j33
0083 D815      dw      5592      j34
0085 6816      dw      5736      j35
0087 F616      dw      5878      j36
0089 B217      dw      6018      j37
008B 0D18      dw      6157      j38
008D 9518      dw      6293      j39
008F 1C19      dw      6428      j40
0091 A119      dw      6561      j41
0093 231A      dw      6691      j42

0095 A41A      dw      6820      j43
0097 231B      dw      6947      j44
0099 9F1B      dw      7071      j45
009B 191C      dw      7193      j46
009D 921C      dw      7314      j47
009F 071D      dw      7431      j48
00A1 7B1D      dw      7547      j49
00A3 EC1D      dw      7660      j50
00A5 5B1E      dw      7771      j51
00A7 CB1E      dw      7880      j52
00A9 321F      dw      7986      j53

```

```

00AB 9A1F      dw      8090      j54
00AD 0020      dw      8192      j55
00AF 6220      dw      8290      j56
00B1 C320      dw      8387      j57
00B3 2021      dw      8480      j58
00B5 7C21      dw      8572      j59
00B7 D421      dw      8660      j60
00B9 2A22      dw      8746      j61
00BB 7D22      dw      8829      j62
00BD CE22      dw      8910      j63
00BF 1C23      dw      8988      j64
00C1 6723      dw      9063      j65
00C3 AF23      dw      9135      j66
00C5 F523      dw      9205      j67
00C7 3824      dw      9272      j68
00C9 7824      dw      9336      j69
00CB B524      dw      9397      j70
00CD EF24      dw      9455      j71
00CF 2725      dw      9511      j72
00D1 5B25      dw      9563      j73
00D3 8D25      dw      9613      j74
00D5 BB25      dw      9659      j75
00D7 E725      dw      9703      j76
00D9 1026      dw      9744      j77
00DB 3526      dw      9781      j78
00DD 5826      dw      9816      j79
00DF 7826      dw      9848      j80
00E1 9526      dw      9877      j81
00E3 AF26      dw      9903      j82
00E5 C526      dw      9925      j83
00E7 D926      dw      9945      j84
00E9 EA26      dw      9962      j85
00EB FB26      dw      9976      j86
00ED 0227      dw      9986      j87
00EF 0A27      dw      9994      j88
00F1 0E27      dw      9998      j89
00F3 1027      dw      10000     j90 degrees

                                end

```

End Listing

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by Michael Wiesenber

A Potpourri of Good-Priced Hardware

The three-inch Winchesters are coming! One of the first is from SyQuest Technology. Their **SQ306** they claim is "the industry's first 3.9-inch (100mm) removable cartridge Winchester disk drive." SyQuest is aiming at the OEM market, but the price of \$400 per unit in large quantities means we can expect to see these five-megabyte Winchesters arrive reasonably priced. The cartridges will sell in quantity for \$30 each. The small size of this unit (1.625 inches tall) allows two SyQuest drives to fit into the same space as one 5.25-inch Winchester or mini-floppy drive. We should see these units integrated, probably stacked two at a time, into the next generation of portable computers. **Reader Service No. 306.**

Monitor the status of the "seven most important" (we are told) RS-232 lines with, what else?, **RS-232 Tester** from B & B Electronics. A female 25-pin connector at one end and a male connector at the other let you attach the Tester directly to the interface and leave it permanently in the line, with LEDs constantly displaying status, but not interfering with data transfer ability. \$39.95 postpaid. **Reader Service No. 316.**

The **SSB-MPF Speech Synthesizer Board** from Etronix provides a 400-word vocabulary for the MPF-1 Micro-Professor, the Z-80-based single-board computer-in-a-book described in a previous column. The board does its input/output with the Micro-Professor's keyboard and speaker, and features a 4K time clock and speech utility EPROM, two EPROM sockets that can be used to expand the vocabulary, adjustable pitch and volume controls, a power adaptor, all necessary connection accessories and a manual. \$129. **Reader Service No. 326.**

A Gallimaufry of Inexpensive Software

AUTODIFF is a file difference detector for CP/M by the Software Toolworks. Not only does this comparison utility list differences between files or produce a copy of the file with all changes flagged, it also reports insertions, deletions and changes, listing them in ASCII or hexadecimal format to a terminal, printer or disk file. Filters can be set to ignore non-printing characters or to display control characters. **AUTODIFF** can be used on most files and costs \$29.95 (plus \$2 postage and handling) on 5-inch disk for

Osborne I and Heath/Zenith, and 8-inch CP/M disk. **Reader Service No. 346.**

Disk-Edit is a screen-oriented disk editor from Supersoft for CP/M programs. It can call up files that, according to Supersoft, "are not even accessible with a normal text editor, then edit those files in either ASCII or hexadecimal notation." The program loads a one-kilobyte section of a disk (hard or floppy) into a buffer, and then displays a dual-view "window" into the buffer. On the left are the hexadecimal values of each byte; on the right, the ASCII. Change either, and the corresponding value changes instantly in the other. Simple commands move the cursor up, down, left, right, to the next page or screen, to the start of the file and so on. There are also string searches and many other functions. **Disk-Edit** has a "terminal definition package" and can be configured to most CP/M systems. \$100, or \$15 for the manual only. **Reader Service No. 356.**

You probably thought that a text editor for the IBM Personal Computer would be expensive, but **WINDOW**, a full-screen text editor program from Intellect Associates Inc., costs \$150. It uses all the screen and keyboard capabilities of the PC, including single-stroke editing commands with the function keys. It's not quite a word processor, but **WINDOW** does most of the things a word processor can, such as easily move the cursor, scroll in four directions, do global search and replace, insert and delete characters and lines, move, copy, split and join lines and edit text files larger than available memory. **WINDOW** runs under IBM-DOS, comes on 5.25-inch diskette, with documentation, and requires 64K, one drive, and a monochrome display and adapter. To turn **WINDOW** into a real word processor, add Intellect's **PCTEXT** for \$100, and get a text processing package that indents, centers, controls line spacing and margins, justifies, inserts headings and footings, numbers pages, underlines and merges documents. It, too, runs under IBM-DOS, requires 48K, one drive and a printer. And while we're talking about Intellect Associates, they offer for the same configuration a data management system, **DMS**, a self-prompting, menu-driven system with which users create data entry forms on the screen in user-specified formats, and then enter, retrieve, modify, correct and delete data with the forms and print reports. The sequential ASCII data base files can be ac-

cessed by any language. **DMS** is written in C88 (Intellect Associates' one-pass-compiler subset of C that costs \$250, generates compact 8088 machine code and comes with a linker), which makes it run, they say, very fast, and also makes good use of the PC's screen and keyboard features. It requires 48K, one drive (two recommended) and monochrome display adapter. **Reader Service No. 366.**

Cross-assemblers can cost a bundle, but here's one for the Zilog Z8 that costs \$150. **SYSTEM-Z8**, by Allen Ashley, for CP/M, includes a down-loader for the Zilog Z8 Development Module to transmit developed programs for in-circuit test. You get a macro-assembler with macro and conditional assembly and chaining, interactive editor/assembler, text editor, cross-reference generator, complete documentation and user support by mail or phone. Current **SYSTEM-Z8** owners can phone for a free update. **Reader Service No. 376.**

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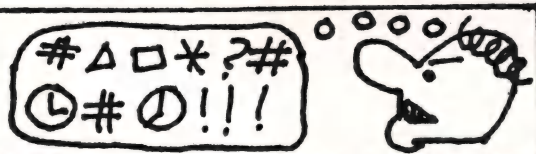
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well, but we'd rather see some evidence. Surely somebody out there has a PC, a suspicious mind, experience with the typical output of translator programs, and a few hours to spare. The MSDOS command DEBUG will disassemble storage. Use Ctrl-PrtSc to start a log of its output on the printer.

Actually, there are very good reasons why Microsoft would translate an existing interpreter rather than write a new one. Their MBASIC is a mature, well-debugged piece of code. Translation would let them produce a reliable product quickly and cheaply. Reliability, quick development, and low cost are three qualities that are conspicuously absent when you build a large piece of software from scratch. One can see how the "technical" consideration of execution speed could easily take a back seat to these desirable "management" criteria. . . .

Burke Smith of Shawnee Mission, KS, has found a bug in that mature product, MBASIC. It only seems to surface in version 5.1 of BASIC-80, and in IBM version D1.00. Try this sequence:

```
LET A#=0
LET A#=-A#
PRINT INT(A#),FIX(A#)
```

Smith claims that in the noted versions (but not in the more common versions 4.51 and 5.2) two answers of -1 will be displayed, "rather than the zeroes that any reasonable person would expect."

Smith goes on to blame the problem on Microsoft's choice of binary floating-point rather than decimal float using a BCD representation. We think that's a red herring. We've seen a lot of misguided complaints along this line; the writers seem to think that there is something peculiar about the binary number system that makes it more prone to truncation errors ("round-off errors") than decimal is. Tain't so; a digit is a digit, no matter what your radix. The problem is the limited precision of the representation, not the number base. A decimal representation of a real number is just as prone to truncation errors as a binary, octal or hexadecimal one is.

There are standard techniques that will mitigate the effect of truncation errors. Hardware designers can incorporate an extra digit of precision in the temporary results held in machine registers, and round any bits that turn up in such

a "guard digit" back into the result before storing the result. Few people remember now, but the initial design for the IBM 360 line lacked guard digits in the floating-point ALU; the first machines had them added in the field as engineering changes. Good scientific calculators get the same effect by carrying several low-order digits that don't show in the display. MBASIC could have achieved the same effect in software; we don't know if it tries to.

A decimal representation is better in just one way: it will get truncation errors on the numbers that people expect it to. Nobody is too surprised when the expression $((1/3)*3)$ does not yield a result of 1.0; most people can picture the string 0.333333 . . . being truncated and multiplied by 3 to yield 0.999999. The trouble with binary (or any other radix) is that some fractions that have finite represen-

tations in decimal become repeating "decimals" in another radix (and vice versa). When the system converts such a constant to its internal radix, it loses some precision before any calculations are done at all. For commercial arithmetic, the only answer is to use a fixed-point decimal representation like the ones available in PL/I and COBOL compilers. Floating-point arithmetic should *never* be used for commercial calculations, no matter what radix it is based on.

John Palmer of Boonville, CA, is grumpy about his new CP/M-86 system, which he procured from Godbout along with the Godbout 8085/8088 dual processor board. "The Godbout hardware is very good," he writes. "If you buy all the stuff from Godbout it will run." However, problems arose when he had to modify the Godbout BIOS. The first problem was that "the BIOS is very hard

SUBMIT.COM

```
; A patch to SUBMIT.COM which forces it to open an existing
; $$$SUB file for appending, rather than erasing it. The
; CCP reads that file in reverse order. Thus a SUBMIT within
; a submitted file will "push" new records onto the end of the
; file, from whence the CCP will "pop" them. The result is
; correct execution of nested SUBMIT commands.
;
subfcb equ 05BBh ; FCB for $$$SUB
BDOS equ 0005h
OPEN equ 0211h ; open-file subroutine of SUBMIT
;
org 022Dh ; the erase-file routine of SUBMIT
;
; It would seem that this location is called when an attempted
; open of $$$SUB succeeds, showing that the file exists.
; Previously, this code would have erased the file.
;
ops1 lda subfcb+15 ; open ok if extent not full
ral ; extent full if record count=>80h
rnc ; exit if count < 80h
lxi h,subfcb+12 ; extent number in FCB
inr m ; try the next extent
; Code to invoke or re-invoke the create-next-extent routine
; of SUBMIT--which will call "ops1" above if the extent exists?
ops lxi d,subfcb ; open first (next?) extent
jmp create
;
; Routine to create the $$$SUB file
;
create org 025Dh
call OPEN ; test $$$SUB by opening it?
inr a ; FFh -> 00h if open fails
jnz ops1 ; do above code if file exists
lxi d,subfcb ; file does not exist, make it
mvi c,22
call BDOS
adi 01h ; set carry flag if retcode=FFh
ret
;
; Replacement code for original logic to open $$$SUB
;
org 04FEh
call ops ; open last extent of $$$SUB
jc 0517h ; error if open failed
lda subfcb+15 ; use the FCB "record count"
sta subfcb+32 ; ..to set the "current record"
jmp 051Dh ; continue with original code?
;
end
```


to modify without the Sorcim anti-Intel ACT assembler." That would make us grumpy, too. There is no excuse for distributing a BIOS that requires an assembler that isn't part of the distributed system. "The source code for the BIOS is on the diskette," Palmer reports, "but you cannot use it until you buy Sorcim's ACT-86 for \$175." Palmer thinks this is a tacky way of selling assemblers, and we agree.

Passing the Hat

We're scraping the bottom of the mailbag again, readers. You've all been very flattering in your praise of this column, but you aren't *contributing*. We need questions, like Knipp's. Pitfalls and Warnings, like Palmer's. Bugs, like Barker's. Patches, like Pasky's. Discoveries, like Hammond's. Puzzles, Confusions. Grumps. Cheap software. *Material!* Please?



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Letters (Continued from page 6)

by *DDJ* readers. First, however, I attacked its primary problem: it's *slow*.

I studied the code for a while, and decided to change the global symbol table from a linearly searched list to a hash table. I also put the macros in the global symbol table, with pointers into the array of macro definitions. Since the original code was well-structured, changing algorithms was not difficult.

I changed "numglbs" from 300 to 512 (a power of two), "SYMTBSZ" from 5040 to 8008, and introduced "#define MASKGLBS 511". I introduced "#define MACRO 5", giving a new possible entry for "ident". Since I'm putting the macro names into the global symbol table rather than the macro table, I changed "macqsize" from 1000 to 500. "macptr" has to be initialized to 1 instead of 0. (Initializing it to 0 causes a subtle bug affecting only the first macro. I'll leave the details as an exercise for the student.)

I added the following initializing code to main():

```
glbptr=STARTGLB;
while(glbptr<ENDGLB){
    *glbptr=0;
    glbptr=glbptr+SYMSIZ;
}
glbptr=STARTGLB+SYMSIZ*5;
/* clear global symbols
*/
```

"dumpglbs()" needed the declaration "int i;", and the top of the loop changed to

```
i=NUMGLBS;
while(i--){ /* 6/19/82 jrvz */
    if(*cptr){
        if((cptr[ident]!=function)
            &(cptr[ident]!=MACRO))
            /* do if anything but
            function or macro
            jrvz 6/19/82 */
```

I introduced a simple hash function:

```
hash(sname)
char *sname;
{
    int h,c;
    h=*sname;
    while(c=*(++sname)) h=(h<1)+c;
    return h;
}
```

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I then rewrote the following routines where boxes indicate changes):

```
findglb(sname)
/* cptr is set to entry if found,
or appropriate empty slot if not */
char *sname;
int h;
h=hash(sname)&MASKGLBS;
cptr=STARTGLB+h*SYMSIZ;
while(0==
astreq(sname,cptr,namemax)){
    if(*cptr==0) return 0;
    cptr=cptr+SYMSIZ;
    if(cptr==ENDGLB)cptr=STARTGLB;
}
return cptr;
}
```

```
addglb(sname,id,typ,value)
char *sname,id,typ;
int value;
{
    char *ptr;
    if(findglb(sname))return cptr;
    if(glbptr>=ENDGLB)
    { error("global symbol table
overflow");
        return 0;
    }
    ptr=cptr;
    while(an(*ptr++ = *sname++));
    /* copy name */
    cptr[ident]=id;
    cptr[type]=typ;
    cptr[storage]=statik;
    cptr[offset]=value;
    cptr[offset+1]=value>>8;
    glbptr=glbptr+SYMSIZ;
    return cptr;
}
```

```
addmac()
{ char sname[namesize];

    if(symname(sname)==0)
    { illname();
        kill();
        return;
    }
    addglb(sname,MACRO,0,macptr);
    while(ch()== ' ' | ch()==9)
        gch();
    while(putmac(gch()));
    if(macptr>=macmax)
        error("macro table full");
}
```

```
findmac(sname)
/* rewritten 6/19/82 jrvz */
char *sname;
{
    if((findglb(sname)!=0)&
    (cptr[ident]==MACRO))
    { return((cptr[offset]&255)+
    (cptr[offset+1]<<8));
    }
    return 0;
}
```

As a result of these changes, the compiler speed has more than doubled. I also enlarged the disk buffers from 128 bytes to

512 bytes. That sped compilation up a further 20%, to about 220 lines/minute on my 2.5 MHz Z-80.

Has anyone installed floating-point variables? Does anyone have a C interpreter, that would let me debug my code quickly? (Note that Tiny-c accepts a different language.)

Keep the Small-C articles coming!

Yours,
James R. Van Zandt
26 Shelton St.
Nashua, NH 03062

Editor's Note: Readers who are following the developments in Small-C, which originated with Ron Cain's Small-C compiler, should keep a close eye on DDJ in the coming months. We have a number of exciting articles and listings scheduled.

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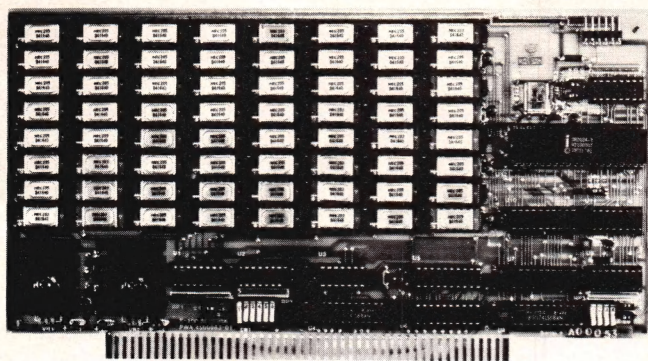
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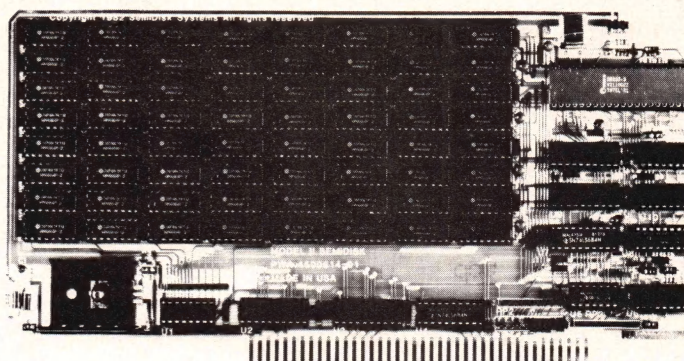
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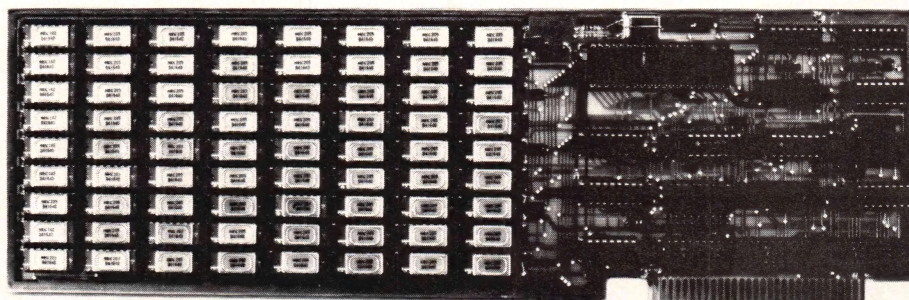
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